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TRANSACTIONS

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OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

Vol. VIII, No. 1, pp. 1-2 August 10, 1934

A NEW SUBSPECIES OF POCKET GOPHER FROM SONORA, MEXICO

BY

Laurence M. Huey

Curator of Birds and Mammals, San Diego Society of Natural History

During February, 1934, a party representing the San Diego Society of Natural History made collections in the vicinity of Punta Peñascosa, on the northeast coast of the Gulf of California, Sonora, Mexico. Among the limited number of mammals obtained is a series of 12 *Thomomys* which represents an undescribed form of the wide-ranging *bottae* group. This race may be known as:

Thomomys bottae vanrossemi subsp. nov.

Punta Penascosa Pocket Gopher

Type.—From Punta Peñascosa, Sonora, Mexico; no. 10922, collection of the San Diego Society of Natural History; adult male; collected by Laurence M. Huey, February 15, 1934.

Characters.—In color *vanrossemi* is almost identical with its nearest relative, *Thomomys bottae phasma* from southwestern Arizona, but cranially some characters showing constant difference are present. The skull is relatively narrower than that of *phasma* with less widely spreading zygomatic arches, narrower rostrum and more fully inflated bullae, that bulge farther below the basioccipital.

Measurements.—Type: Total length, 215; tail, 72; hind foot, 28; ear, 4. *Skull* (*type*): Greatest length, 38.5; spread of maxillary arches, 24.0; length of nasals, 13.5; interorbital constriction, 6.5; alveolar length of upper molar series, 7.5.

Range.—So far as known, the vicinity of Punta Peñascosa, Sonora, Mexico,

where it was found living at almost tide level on the land side of a series of large sand dunes that bordered the sea beach.

Remarks.—Since Nelson and Goldman have recently described a number of forms of *Thomomys* from Sonora (Journ. Mam., Vol. 15, no. 2, May, 1934, pp. 105-124), the writer forwarded this series of specimens to Washington, where it was compared with topotypical material by Major Goldman and the differences confirmed. For this aid the writer's thanks are here expressed.

Specimens examined by the writer.—Thomomys bottae phasma: 5 from Tinajas Altas and 13 from 4 miles south of Gadsden, Yuma County, Arizona; *Thomomys bottae vanrossemi*: 12 from Punta Peñascosa, Sonora, Mexico [type locality].

This race is dedicated to Mr. A. J. van Rossem of the California Institute of Technology, a life-long friend of the author and co-worker in the field of natural science.

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. VIII, No. 2, pp. 3-4 AUGUST 10, 1934

A NEW PUFF-BIRD FROM EL SALVADOR

BY

A. J. VAN ROSSEM

California Institute of Technology

In view of Ridgway's remarks (Birds of North and Middle America, 6, 1914, 377, footnote) concerning the individual variation found in Dyson's Puff-Bird, the eight specimens of this species which I collected in El Salvador in 1925, 1926, and 1927 had been referred to *Notharchus hyperrhynchus dysoni,* purely on assumption. Last fall when at the Museum of Comparative Zoölogy, I chanced to see a large series of *dysoni* which were so very different from my recollection of the Salvador birds that I asked Mr. Peters to forward a good selection in order to make possible a direct comparison. Further specimens were borrowed from the Bureau of Biological Survey and the Smithsonian Institution. The total series of *dysoni* examined at this time numbers 28 specimens from practically the entire Central American range save for the Pacific coast of Nicaragua and Guatemala.

The Salvador birds represent a strongly characterized race which evidently occupies a limited territory on the Pacific coast of Central America. This race is here named

Notharchus hyperrhynchus cryptoleucus subsp. nov.

Type.—Male adult, no. 18714 Dickey collection; Barra de Santiago, Dept. of Ahuachapan, El Salvador, April 3, 1927, altitude sea level; collected by A. J. van Rossem, original number 11580.

Subspecific characters.—Compared with *Notharchus hyperrhynchus dysoni*: feathers of lower rump and upper tail-coverts with one or two concealed grayish-white bars, instead of being immaculate proximal to the terminal tipping; dark

portions of the plumage everywhere, save on the crown, paler, duller, and more slaty, and with the white margins notably wider; rump and upper tail-coverts "mouse gray" instead of "dark mouse gray" or "blackish mouse gray"; flanks with dark area much restricted and narrowly barred with brownish slate and white in about equal widths instead of being black with narrow white bars.

Range.—Coastal plain of El Salvador and, probably, closely adjacent areas in western Guatemala and western Nicaragua.

Remarks.—The concealed barring is a feature which is apparently totally absent in *dysoni* and always present in *cryptoleucus*. Aside from this, *cryptoleucus* is easily distinguished by general pallor of coloration and wide white tipping and margins.

Sclater's type of *Bucco dysoni* came from "Honduras" and was collected by Dyson. This necessarily restricts the type locality to northwestern Honduras, since the chief purpose of Dyson's visit was to secure live specimens of the Ocellated Turkey for the aviary of Lord Derby.

Specimens of *dysoni* have been examined from Honduras (Santa Ana); British Honduras (Toledo District); Guatemala (Gualan); Costa Rica (Pigres; Boruca); Panama (Loma del Leon; Panama City; Almirante; Fruitdale); Chiapas (San Benito). I can make out no variation in this extensive range, that is other than individual or seasonal in character. The margins to the dark parts of the plumage are naturally wider when the feathers are fresh and gradually disappear with wear.

The fact that *dysoni* occurs in typical form at the Chiapas-Guatemala boundary on the Pacific coast, and as far north as Pigres on the Gulf of Nicoya in Costa Rica, argues a relatively limited range for *cryptoleucus*. However, since *cryptoleucus* was found to inhabit the full length of the coastal plain of El Salvador, it would be remarkable if it did not extend for some slight distance into the adjoining portions of Guatemala and Nicaragua.

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. VIII, No. 3, pp. 5-8 AUGUST 10, 1934

NOTES ON THE RACES OF CLARAVIS MONDETOURA

BY

A. J. VAN ROSSEM

California Institute of Technology

Ludlow Griscom (Occ. Pap. Bost. Soc. Nat. Hist., 5, June 14, 1930, pp. 287-292) has recently recognized four races of this little dove, though he was able to assemble little more than a dozen specimens from American collections. In the interval since Griscom's paper appeared I have had the opportunity to examine most of his material and also some twenty additional skins in Europe and England. As might be expected the foreign material modifies, somewhat, the characters of the four races defined by Griscom. This comment is given below and, in addition, two more races are described, respectively from the southern and northern extremes of the range of the species.

Claravis mondetoura mondetoura (Bonaparte)

As first noted by Count Salvadori (Cat. Birds Brit. Mus., 21, 1893, 495) and later by Ridgway and Griscom, South American specimens are sharply distinguished from those of Central America and Mexico by the reddish intermixture in the slate color of the under wing-coverts and axillars of the males.

The typical race, *mondetoura,* is distinguished from all the others, both north and south, by the longer wing. Seven fully adult males measure: wing, 117-121; tail, 85-91 mm. Five fully adult females measure: wing, 115-118; tail, 74-82 mm. Bonaparte's types (male and female) from Caracas, Venezuela, were examined in the Paris Museum. They are typical of the northern South America subspecies.

Sixteen specimens of both sexes and representing adult and immature individuals have been examined from Venezuela, Colombia and Ecuador. Age for

age, I am unable to see any differences between birds from these three countries and believe that the characters noted by Griscom for some Colombia females were due to age. Old females are very much grayer than immatures.

Claravis mondetoura inca subsp. nov.

Type.—Male adult, no. 89.4.20.365 British Museum; Huasampilla, Peru, March 18, 1872; collected by H. Whitley.

Subspecific characters.—Adult male with under wing-coverts and axillars much more extensively rufous than in typical *mondetoura*, in fact with rufous in excess of slate; flanks paler gray, and posterior median underparts more extensively white than in any other race. Wing shorter than in *mondetoura*. The type, which is apparently the only known specimen, measures: wing, 111; tail, 76; exposed culmen, 13.5; tarsus, 24.0; middle toe minus claw, 21.5 mm.

Range.—Known only from the type locality.

Remarks.—Colors of soft parts as recorded by the collector are: "Bill black; eye pink; legs and toes lead colour." This is not at all in agreement with the colors given by Salvin and Godman in the 'Biologia' for an adult male of *salvini* from Guatemala.

Claravis mondetoura pulchra Griscom
Claravis mondetoura umbrina Griscom

Western Panama and Costa Rica specimens appear to be non-existent in European collections. Therefore, I have nothing to add to the diagnosis of either of these races. I have examined the same specimens used by Griscom, however, and believe that they are both valid subspecies.

Claravis mondetoura salvini Griscom

This race, though described on the basis of a single adult male, is verified through two males and a female from Volcan de Fuego in the British Museum. Males are indistinguishable from *mondetoura* dorsally. They show more white ventrally, but this may be due to the "make" of the skins. The supposed character of a more extensively black tail does not prove constant. In other words the males of *salvini* may be distinguished from *mondetoura* by the possession of uniform slaty (instead of mixed slaty and rufous) under wing-coverts and axillars; and shorter wing with proportionally longer tail.

A single female (also from Volcan de Fuego), is very close to *mondetoura*, but differs in having a slightly darker and less reddish rump and upper tail-coverts, more slaty (less reddish) under wing-coverts, and shorter wing.

Two adult males measure: wing, 110-114; tail, 79-83 mm. One adult female measures: wing, 110; tail, 79 mm.

Though Volume 21 of the 'Catalogue of Birds' cites one male and two females from Volcan de Fuego, this is in error for there are two males and one female from that locality in the British Museum collection at this time. One of the males was recorded by Salvin and Godman as having the colors of the soft parts as follows: "Iris reddish-orange; bill black; tarsi and toes dull red; claws black."

Claravis mondetoura ochoterena subsp. nov.

Type.—Male adult no. 89.4.20.366 British Museum; Jalapa, Vera Cruz, Mexico, 1872; collected by [Rafael Montes] de Oca.

Subspecific characters.—Adult males similar to *Claravis mondetoura salvini* of Guatemala, but dorsal coloration darker and more fuscous (less grayish) slate; underparts darker everywhere and with the red of the pectoral region extending back laterally to tinge the slate color of the flanks. Female unknown.

Range.—Mountains of the State of Vera Cruz, Mexico.

Remarks.—Ridgway (Birds of No. and Mid. Amer., Pt. 7, 1916, 436, footnote), has remarked on the characters shown by the two subadult males in the United States National Museum, but he suspected that the peculiarities might be due to age. The fully adult male in the British Museum shows that such is not the case. The Mexican race is easily distinguished by being the darkest of the known subspecies.

Three males, two of them subadult, but which possess the primaries and rectrices of maturity, measure: wing, 107-113; tail, 72-83 mm.

I take pleasure in naming this dove for Professor Isaac Ochoterena, Director of the Biological Institute of Mexico, not only in recognition of his own work but in appreciation of his assistance in furthering my own activities in northwestern Mexico.

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. VIII, No. 4, pp. 9-12 AUGUST 10, 1934

NOTES ON SOME RACES OF CEOPHLOEUS LINEATUS (LINNAEUS)

BY

A. J. VAN ROSSEM

California Institute of Technology

A few years ago J. L. Peters briefly reviewed[1] the races of this species, but in certain instances he was handicapped either by lack of material or because type specimens were not available for critical examination. It has been my good fortune to be able to study, during the summer of 1933, types of some of the races described by European ornithologists, and it is now possible to settle some, at least, of the questions concerning which Peters was obliged to make arbitrary decisions. Notes on these types and changes in nomenclature (where necessary) are given below.

Ceophloeus mesorhynchus Cabanis and Heine

The three specimens on which this name[2] is based are still in the Zoological Museum in Berlin, where they are numbered 16,292-3 and 4, respectively. They are all mounted in fair condition though all show some degree of moult.

This name comes dangerously close to being a synonym of *Picus similis* Lesson. One of the three cotypes (♂ no. 16,292) is a white-billed bird from the Aguacate Mountains, collected by Hoffmann; another, (♂ no. 16,293), collected by von Frantzius in "Costa Rica," has a pale yellowish brown bill and is also intermediate in other particulars. Only one specimen, (♀ no. 16,294), fulfills all requirements and is typical of the race which has so long borne the name *mesorhynchus*. Although the original description expressly calls for "Bill bright bluish-horncolor," the name "*mesorhynchus*" would seem to indicate recognition

[1] Occ. Pap. Bost. Soc. Nat. Hist., 5, Sept. 2, 1930, pp. 317-22.

[2] Mus. Heineanum, 4, heft 2, 1863, 86. See also critical comment on these specimens in Journ. für Orn., 1862, 176.

of the intermediate character of the bill when the three birds as a whole were considered.

Since the Cabanis and Heine description is a composite, based on two races, it is proper to designate one of the three cotypes as *the* type. Therefore I name number 16,294, as the only course which will permit (for the time at least) retention of this long-established name for the dark-billed race of the Pileated Woodpecker in eastern and southern Costa Rica.

This specimen is a mounted bird, a female, presumably adult, which has nearly completed the annual moult. It has the following measurements: wing, 181; tail, 122; culmen from base, 35.0; tarsus, 26.7; outer anterior toe minus claw, 20.5. The bill is dark horn-color on the maxilla and basal two-thirds of the mandible. The tip of the mandible is dull brown. Though the type locality as published was simply "Costa Rica," Dr. von Frantzius has given a good indication of the locality in which his two specimens were collected. In his paper on the distribution of birds in Costa Rica he states, under the name of *Dryocopus scapularis*,[3] that the species is relatively rare and is known only from the Aguacate Mountains and on the Sarapiqui. The Aguacate record was made by Hoffmann, and therefore the locality from whence came Dr. von Frantzius' two specimens must necessarily be the Sarapiqui River. This is a region of intergradation between *mesorhynchus* and *similis*. It may be that the male, which is an intermediate (though nearer *similis*), was taken at a point further down stream and closer to the Honduras Boundary than was the female, which is typical of the southern race.

There is still the possibility that a good series of specimens from even the headwaters of the Sarapiqui would show a mass average considerably closer to *similis*, and in that case the name *mesorhynchus* will have to become a synonym of the former race. It is significant that Ridgway[4] has considered a specimen from the Río Revantazón, a point considerably to the south of the Sarapiqui, as being an intermediate, which is closer to *similis* than to *mesorhynchus*. I have tried to make out a case which will permit the retention of an old name rather than to scrap it for a new one, though until adequate material from the type locality is collected there is no certainty that even the arbitrary selection of a type finally disposes of the matter.

Campephilus leucorhamphus "Licht." Reichenbach

Peters is entirely correct in considering this name a synonym of *Picus similis* Lesson, for two of the three specimens which were the basis of Lichtenstein's manuscript name[5] are still present in the collection of the Zoological Museum in Berlin. Both are females (the male possibly went to Reichenbach, though I could not find it at Dresden), and are normal representatives of *similis*. They were collected by Ferdinand Deppe; no. 10375 at "Cosmalvapan" [=Cosamaloapam], and no. 10376 at Alvarado. Both of these localities are in southern Vera Cruz.

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[3] Journ. für Orn., 1869, 364.

[4] Birds of No. & Mid. Amer., pt. 6, 1914, 151, footnote.

[5] Nom. Aves. Mus. Berol., 1854, 75.

The wing measurement of these two cotypes, which are mounted and in fair condition, are 174 and 167 mm., respectively.

Campephilus lineatus Var.? **C. leucopterylus** Reichenbach

Reichenbach's type of *leucopterylus*[6] is in the Dresden Museum. It is an adult male, a skin in good condition and bears the following label "Geophloeus [sic] lineatus (L.) /7487/ Süd-Amerika." This relatively new label has the old, badly torn, original pasted on the reverse. All that is left is the single word "Leucopterylus" and the terminal letter (n) of a word which once was written on the now missing lower left hand corner of the label. Dr. Wilhelm Meise, the curator of birds at the Dresden Museum, told me that this skin (formerly mounted) is a part of the old collection of Reichenbach's regime. So far as Dr. Meise could determine there never was a female *leucopterylus* in the collection and he thinks it possible that the figure of the female was pictured by the analogy of the color characters of allied species.

This specimen belongs to none of the northern races but is one of those rare individuals of *Ceophloeus erythrops* which show traces of a white scapular stripe! It fits the colored plate and accompanying description perfectly, even to the light spots on the tips of the alula and primaries, and my own measurement of the wing, 191 mm., is exactly the length given by Reichenbach (7″ 4‴ using the Rhineland foot).

The missing corner of the label, which presumably bore the locality, may have been torn off even prior to the time *leucopterylus* was described, and Reichenbach evidently guessed at the source when he ascribed his bird to "Mexiko." In the Berlin Museum there is another example of *erythrops* which shows the same type of coloration. It was collected by Euler at Cantagallo, Province of Rio de Janeiro, Brazil, and it is not impossible that Reichenbach's bird has the same origin. Dr. Meise could give me no definite information as to why the "Süd-Amerika" had been put on the newer label.

Whether traces of white scapular stripes in occasional specimens of *erythrops* indicate intergradation with *lineatus* or whether the character is a sporadic one which appears in a limited number of individuals, regardless of locality, I do not know. At any rate it is doubtful if *erythrops* is entitled to more than subspecific rank as a race of *lineatus*.

The large race of *lineatus* in north-eastern Mexico, *Ceophloeus lineatus leucopterylus* Peters (nec. Reichenbach), is here named as

Ceophloeus lineatus petersi subsp. nov.

with the type an adult male, no. 31,833 Dickey collection at the California Institute of Technology; Cuidad Victoria, Tamaulipas, Mexico, March 3, 1908; collected by F. B. Armstrong. Measurements of the type are: wing, 190; tail, 116; exposed culmen, 38.0; tarsus, 32.6; outer anterior toe, 26.5.

Picus scapularis Vigors

Peters had only two birds which he considered to be referable to *scapularis*, a male and female taken at Alamos, Sonora.

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6 Handb. Scans. Picinae, 1854, 392, pl. 647, figs. 4319-4320.

The type locality of *Picus scapularis* is San Blas, in what is now the state of Nayarit, western Mexico. Although Vigors' types of this race are stated to have gone to the Zoological Society, they are not now in the collection at the British Museum and were probably long ago destroyed. However, I have examined two specimens of this race from the type locality (in the collections of the British Museum and U. S. Biological Survey) as well as eleven others from various points in Guerrero, Jalisco and southern Sinaloa north to Mazatlan. The race *scapularis* as represented by specimens from the above states is not markedly different in color from *similis*, the race which occurs over most of Central America north to central Vera Cruz on the Atlantic coast and to central Oaxaca on the Pacific. The only color differences which I can observe are that *scapularis* is slightly less buffy below as an average character, and the white sub-ocular streak is narrower and is often broken up by the intrusion of black streaks from the surrounding areas. These characters are fairly uniform over the entire area outlined above, though Guerrero specimens are, naturally, very close to *similis*. In northern Sinaloa and southern Sonora there is an abrupt color change, in that the sub-ocular streak becomes practically obsolete, the ground color of the underparts is whitish rather than buffy, and the wing lining is cream-colored instead of distinctly yellow. On a color basis, therefore, *scapularis*, though uniform over a large area, is an intermediate between *similis* and birds of the Alamos district of Sonora and northern Sinaloa.

In size, however, *scapularis* is small, decidedly smaller than *similis* and slightly smaller than the Alamos birds. The largest male out of five from Mazatlan, the northernmost point from which I have seen specimens of *scapularis*, has a wing and tail length of 167 and 105 mm. respectively. Ridgway gives essentially the same figures as the average for the race, but I suspect that central Sinaloa specimens are included.

Specimens from the Alamos Faunal Area represent the pale extreme reached by *Ceophloeus lineatus* in North America. The race is here described as

Ceophloeus lineatus obsoletus subsp. nov.

Type.—Adult male, no. 224,294, Mus. Comp. Zoöl.; Alamos, southern Sonora, Mexico; March 16, 1888; collected by M. A. Frazar.

Subspecific characters.—Nearest to *Ceophloeus lineatus scapularis* (Vigors) of central western Mexico, but ground color of underparts pale buffy white or grayish white instead of pale buff; wing lining cream-color instead of light yellow; sub-ocular and sub-auricular streak nearly obsolete; wing and tail slightly longer.

Range.—The Alamos District in southern Sonora, northern Sinaloa and probably the adjacent portions of Chihuahua.

Remarks.—Seven specimens of this race have been examined from Alamos, Sonora, and from Rosario and La Guasimas in extreme north-eastern Sinaloa. Two, from Rosario and La Guasimas, respectively, are young birds. Five adults of *obsoletus* average (sex ignored): wing, 172.3; tail, 110.5. The characters as given by Peters for "*scapularis*" apply, of course, to *obsoletus*.

In addition to the institutions mentioned above I am indebted to Robert T. Moore for the loan of specimens from northern Sinaloa.

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TRANSACTIONS

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VOL. VIII, No. 5, pp. 13-14 MARCH 21, 1935

THREE NEW SPECIES OF PINNIXA FROM THE GULF OF CALIFORNIA

BY

STEVE A. GLASSELL

Research Associate in Crustacea, San Diego Society of Natural History

The crabs here described were collected at the upper end of the Gulf of California, near the village of San Felipe, in Lower California, Mexico, by the author. Fuller descriptions and plates of the following species will appear in a forthcoming partial revision of the genus *Pinnixa* by the writer.

FAMILY PINNOTHERIDAE

Pinnixa abbotti, sp. nov.

Type.—Female, San Diego Society of Natural History, Cat. No. 208; San Felipe, Lower California, June 10, 1933. Allied to *P. floridana.*[1] Carapace a little wider than twice the length. Antero-lateral margin rounded, marked with a distinct punctate ridge, extending from the cervical groove and meeting the concave postero-lateral margin at an acute angle. Entire carapace coarsely punctate; pubescent near outer angles; a transverse groove between gastro-cardiac regions; a median sulcus. Front truncate, slightly concave, entire. Mesogastric region depressed. Chelipeds weak, hairy, pubescent; carpus punctate; chela tapering distally; inside of hand smooth; fingers feebly denticulate, nearly horizontal, not gaping, tips hooked. Length of carapace 2.95, width 6.5 mm.

Pinnixa fusca, sp. nov.

Type.—Female, San Diego Society of Natural History, Cat. No. 209; San Felipe, Lower California, May 29, 1934. Allied to *P. longipes.*[2] Carapace slightly

[1] Bull. 97, U. S. Nat. Mus., 1918, pl. 30, figs. 4-7.

[2] Proc. Calif. Acad. Sci., ser. 2, vol. 4, 1894, p. 573, pl. 20, figs. 19-20.

more than three times the length, and rounding down to margins, smooth; regions poorly defined. Front truncate, slightly convex, not extending beyond carapace; posterior margin concave. Chelipeds equal; upper distal end of merus extends over carpus; carpus and hands smooth; hands rounded, tapering distally; fingers slightly gaping, one large central tooth; pollex slightly deflexed, tip hooked. First and second ambulatory legs, slight, third and fourth, heavy; fourth reaches nearly to middle of propodus of third; dactyls of first and second legs long and slim, curved third and fourth, long and heavy, curved at tip, upper crest of tip of third dactyl, tri-dentate, fourth smooth. Abdomen covers sternum. Length of carapace 3.7, width 11.5 mm.

Pinnixa felipensis, sp. nov.

Type.—Female, San Diego Society of Natural History, Cat. No. 210; San Felipe, Lower California, June 1, 1934. Carapace slightly more than 2½ times the length, and rounding down to margins in front, smooth, depressed in central portions; regions defined; an unbroken, straight, transverse cardiac ridge, extending across the carapace; front very broadly triangular, concave toward orbits; posterior margin straight. Chelipeds unequal, dissimilar; merus long, increasing in breadth with length, carpus narrow, long, overhanging the manus, smooth; hands crested, wide, smooth; pollex of larger hand, short, horizontal, thick; of smaller hand, longer, lighter and pointed; fingers, greatly curved, gaping, a tuft of dense pubescence in the gape. First and second ambulatory legs, slight, dactyls long, tapering, bi-curved; dactyls of third and fourth legs, long, lanceolate, straight; dactyl of fourth leg reaches carpus of third leg. Abdomen nearly covers sternum. Length of carapace 3.2, width 8.3 mm.

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

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NEW MARINE MOLLUSCA FROM WEST MEXICO, TOGETHER WITH A LIST OF SHELLS COLLECTED AT PUNTA PENASCO,[1] SONORA, MEXICO

BY

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San Diego Society of Natural History

The following undescribed species of mollusks were taken by the author on the west mainland coast of Mexico in 1930 and 1931, at various points in the Gulf of California in 1932, at San Felipe, Lower California, in May, 1933, and at Punta Peñasco, Sonora, in February, 1934. Descriptive accounts of the various collecting trips will be found in "The Nautilus" as follows: Mazatlan-Guaymas-Topolobampo, Vol. XLIII, pp. 135-138; Tres Marias-Manzanillo-Acapulco, Vol. XLIV, pp. 24-27; Gulf of California and its islands, Vol. XLVI, pp. 73-76, 109-115; San Felipe, at the head of the Gulf, Vol. XLVII, pp. 45-47; Punta Peñasco, on the northern Sonora coast, Vol. XLVIII, pp. 1-4, 43-46.

I am indebted to Mr. J. R. Pemberton of Los Angeles for the privilege of being included in the party of scientists which cruised in the Gulf of California during the early part of 1932. I also wish to thank the officials of the San Diego Society of Natural History for facilities provided on the co-operative expedition to Punta Peñasco, Sonora, in February, 1934. The splendid research library of Dr. U. S. Grant at the University of California at Los Angeles was of great assistance in the preparation

[1] Also known as Punta Peñascosa.

of the paper. Finally, the fullest credit is due to Mr. Ernest H. Quayle of the Department of Geology, University of California at Los Angeles, for the excellent pen and ink drawings here reproduced.

BIVALVES

Arca gordita, new species. Plate 1, fig. 1.

Acapulco, 20 fathoms (1931). Type 11387, Lowe collection; paratype, Lowe collection, Guaymas, 20 fathoms, (1932).

Shell irregularly ovoid, solid; anterior end roundly sloping downward and backward, posterior end roundly, obliquely produced; color flesh-white; about 27 radiating ribs with somewhat wider interspaces; dorsal margin nearly straight, ventral margin much rounded; greatest altitude of shell in almost vertical line with umbones; anterior wing more sharply produced than the posterior.

Diameter 30 mm., altitude 19.1 mm.

This shell has about nine less ribs than *A. aviculoides* Rve., and is a thicker and heavier shell for the same size.

This species and the two following, *A. delgada* and *A. reinharti,* have subsequently turned up in the dredgings of the Templeton Crocker Expedition off West Mexico, (August, 1933).

Arca delgada, new species. Plate 1, fig. 2.

Manzanillo, 20 fathoms (1930). Type 11388, Lowe collection.

Shell very obliquely ovoid, rather solid; anterior end roundly sloping downward and backward; posterior end roundly obliquely produced; color gray white; about thirty delicately nodulous ribs, growing smaller and closer together toward the anterior end. Between the longest four ribs are delicate riblets. The shell is rather flat sided and the ligamental area about normal.

Diameter 12.3 mm., altitude 8 mm.

Arca (Anadara) reinharti, new species. Plate 1, figs. 3a, 3b, 3c.

Guaymas, 20 fathoms (1932). Type 11389, Lowe collection.

Shell ivory white, covered with a brown, horny epidermis; obliquely rhomboid, solid, equivalve; edges of valves thick; anterior end rounded, posterior end angularly extended downward; about 25 radiating ribs, with narrow interspaces; the ribs toward the anterior end are strongly nodulous. The shell somewhat resembles a miniature specimen of *A. multicostata* Sby., but is much more oblique, has about ten less ribs, and has a ligamental area (in specimens of equal size) of three times the diameter. In young *A. multicostata* the left valve overlaps the right.

In young *A. multicostata* the edges of the valves are quite thin, while those of the species under discussion are abnormally thickened; the grooves on the inner margin of the valves extend almost four times as far within the shell.

To compare the new species with one of almost the same size of *A. multicostata* the following measurements are given:

Arca reinharti—diameter 27.7 mm., altitude 22.1 mm., thickness 24.5 mm.

A. multicostata (young)—diameter 29 mm., altitude 27.5 mm., thickness 20 mm.

The species is named in honor of Philip W. Reinhart, of Stanford University, who has done most excellent work in West Coast Paleontology, especially in the Arcidae.

Phacoides (Pleurolucina) leucocymoides, new species. Plate 1, fig. 4.

Tres Marias (1930). Type 11386, Lowe collection; paratypes, San Diego Society of Natural History, Carmen Island, Gulf of California, 20 fathoms (1932) and Lowe collection, Angel de la Guardia Island, Gulf of California, 20 fathoms (1932).

Shell convex, thin, white; entire surface covered with sharply reflexed concentric lirae, which are much stronger and further apart than in *Phacoides undatus* Cpr. Instead of three radiating costae with four narrow interstices on each valve, as in Carpenter's species, there is but a single wide costa with a channeled groove on either side. The shell is higher and narrower than *P. undatus* and somewhat resembles *P. leucocyma* Dall (Proc. U. S. Nat. Muse., vol. 12, p. 263, pl. 14, figs. 6-7, 1889) from the Atlantic coast. The interior marginal crenations and cardinal teeth are more prominent than in *P. undatus* Cpr., while the subumbonal pit is not so deep as in that species.

Diameter 10.7 mm., altitude 11.1 mm.

Lithophaga abbotti, new species. Plate 1, fig. 5.

Kino Bay, Sonora, tidal zone (1932). Type 11390, Lowe collection; paratypes, San Diego Society of Natural History and Academy of Natural Sciences of Philadelphia.

Shell cylindrical, thin, posteriorly obtusely rounded, anteriorly tending to subangulation above, evenly rounded below; growth lines are plainly visible under the shining light brown epidermis. The whole shell is covered with a lime incrustation somewhat ruffled in the central portion of both valves. The anterior end is less attenuated than either *L. attenuata* Desh. or *L. aristata* Hanley.

Diameter 62.5 mm., altitude 19.5 mm.

The type and several additional specimens were obtained in a mass of worm tubes, coralline growths and lime incrustations on a tidal bar a mile or more back in the estuary at Kino Bay, January, 1932. A single specimen was taken in 1933 at San Felipe on the western side of the Gulf of California.

In the U. S. National Museum is a single specimen (#381411) of the above species marked from San Lucas Island, Costa Rica, which measures as follows: length 40.4 mm., width 12.5 mm.

This largest of our West Coast *Lithophaga* is named in honor of Clinton G. Abbott, Director of the Natural History Museum, San Diego, California.

Solen pazensis, new species. Plate 1, fig. 6.

La Paz, Lower California, tidal zone (1929). Type 11391, Lowe collection; paratypes, San Diego Society of Natural History and Academy of Natural Sciences of Philadelphia.

Shell transversely oblong, with anterior terminal beaks; anterior extremity

obliquely truncated; posterior extremity rather squarish; dorsal and ventral edges very slightly curved; hinge and ligament similar to *S. sicarius* Gld. Epidermis shining horn color, with a darker blotch on the anterior ends and a darker triangle formed by a line from anterior dorsal end to posterior ventral end, instead of the rosy suffusion as in *S. rosaceus* Cpr. Where the epidermis is removed near the beaks, a somewhat darker color is seen in parallel lines corresponding to the lines of growth.

Diameter 57.5 mm., altitude 11.5 mm.

Comparative dimensions are as follows:

Solen sicarius Gld.: diameter 55.5 mm., altitude 14.5 mm.
Solen rosaceus Cpr.: diameter 57.5 mm., altitude 13.5 mm.
Solen mexicanus Dall: diameter 60 mm., altitude 8.5 mm.

Psammosolen guaymasensis, new species. Plate 1, fig. 7.

Guaymas, 20 fathoms (1932). Type 11392, Lowe collection; paratype, Lowe collection, off Angel de la Guardia Island, Gulf of California, 20 fathoms.

Shell oblong-oval, rather thin, convex; extremities equally rounded; dorsal and ventral markings nearly parallel. Beaks not prominent, much nearer the anterior end. Color white; unequal striae of growth crossed by numerous diagonal incised lines. Pallial sinus wide and three-fourths length of shell.

Type: diameter 48.5 mm., altitude 20.3 mm.

Paratype: diameter 18 mm., altitude 8.5 mm.

Both type and paratype are right valves.

Leda (Adrana) penascoensis, new species. Plate 1, fig. 8.

Punta Peñasco, Sonora, dredged 10 fathoms (1934). Type 11393, Lowe collection.

Shell white, with a straw-colored glossy periostracum; strongly compressed beaks much nearer the anterior end. Dorsal line nearly straight, ventral margin curved, anterior and posterior ends about equally angular. Dorsal edges of both valves slightly crenate the entire length. Sculpture of fine concentric lines of growth over the entire surface of both valves, except a narrow portion bordering the posterior dorsal margin, which is entirely smooth.

Diameter 37.5 mm., altitude 9.4 mm.

This shell differs considerably in sculpture and shape from the three other forms described in this group from West America.

Venus kellettii, Fbs. Plate 2, fig. 1.

Carmen Island, Gulf of California, 20 fathoms (1932).

Venus mariae Orb. Plate 2, fig. 2.

Santa Maria Bay, Lower California, 20 fathoms (1931).

Plate 2, figure 1, shows the young stage of *Venus kellettii* Fbs. At this period of its growth, it more resembles *Venus mariae* Orb., figured in Plate 2, figure 2, than the adult form, which is well illustrated in Reeve, Conch. Icon., vol. 14, pl. 18, fig. 82, but which shows none of the exquisite earlier sculpture. Had I not an adult specimen of this species, I should have unhesitatingly con-

sidered it a new species in a group with *Venus mariae* Orb., which it resembles both in form, size, and sculpture. For this reason it seems well to figure the two species for comparison.

Measurements of the *Venus kellettii* Fbs. figured are diameter 16.7 mm., altitude 11.3 mm.; of the *Venus mariae* Orb., diameter 15.4 mm., altitude 12 mm.

UNIVALVES

Calliostoma marshalli, new species. Plate 2, fig. 3

San Felipe, Gulf of California (1933). Type 11380, Lowe collection; paratypes, San Diego Society of Natural History, U. S. National Museum and Academy of Natural Sciences of Philadelphia.

Shell conic, elevated, rather thin; imperforate, light cinnamon brown, with, on the body whorl, about 14 sagittate flames of darker brown, bordered by a white anterior zone, running from suture to umbilicus. Five rounded whorls besides 2 nuclear; sutures distinct; on the penultimate whorl thirteen fine but sharply crenate spiral threads, on the preceding whorl seven, and on the others three. Base slightly convex with about 20 flat spiral threads with narrower interspaces, the fourth, eighth, and twelfth showing regular square dots of dark brown. Columella excurved, pearly white; umbilical callus slightly depressed. Aperture rounded, irridescent within; outer lip thin, with faint lirations within.

Diameter 13.5 mm., altitude 14.1 mm.

I take pleasure in naming this species for Mr. W .H. Marshall, who has given so many years of valuable service to the U. S. National Museum in the Department of Mollusks.

Calliostoma gemmuloides, new species. Plate 2, fig. 4.

Tepopa Bay, Sonora (1932). Type 11382, Lowe collection.

The description of this beautiful species may most clearly be given by comparison with the well known *C. gemmulatum* Cpr. It is a narrower shell; being a full millimeter less in diameter than a *gemmulatum* of equal height. The sutures are well defined but lack the deep channeling of *gemmulatum*, whorls more sloping, less angular. The beaded spiral lines are not so prominent as in *gemmulatum* and more in number. On the base are two extra spirals; above the periphery of body whorl are three extra spirals; on the penultimate one extra. Color dark reddish brown with nine radial flames of a lighter color. Six whorls exclusive of the two nuclear.

Diameter 12 mm., altitude 13.5 mm.

Calliostoma angelenum, new species. Plate 2, fig. 5.

Angeles Bay, Lower California (1932). Type 11381. Lowe collection.

Shell conic elevated, thin, imperforate, color reddish brown, with a few white dots around periphery of body whorl; whorls rather flat, six in number besides the two smooth nuclear; sutures distinct; base rounded; columella excurved, pearly white; umbilical callus slightly depressed. Aperture rounded, irridescent within; outer lip thin, with faint lirations within. There are on the base 16 strap-like spirals with equal interspaces, three nearest the umbilical callus

stronger; on the body whorl above the periphery are 13 regularly beaded spirals and on the penultimate whorl seven, antepenultimate five.

Diameter 13 mm., altitude 14.5 mm.

Tritonalia carmen, new species. Plate 2, fig. 6.

Angel de la Guardia Island, Gulf of California, 20 fathoms (1932). Type 11378, Lowe collection; paratype, San Diego Society of Natural History.

Shell solid turreted, of four angular whorls and three rounded nuclear and post-nuclear whorls, suture distinct, each whorl with sloping shoulders, the lower four prominently angular at the periphery. Below the periphery on the body whorl is a lesser spiral angulosity and a smaller spiral cord below that. Outer lip thin, inner lip covered with a white callous, canal short, moderately wide, and slightly bent to the left. Faint incremental lines are visible over the entire surface. Color of shell a light cream with a few light brown flecks on upper portion of each whorl.

Diameter 5 mm., altitude 9 mm.

The paratype specimen was dredged off Carmen Island in 20 fathoms. Under catalogue number 96326, the U. S. National Museum has three examples of this species dredged in 9 fathoms off La Paz. They had been tentatively identified as young of *Murex squamulatus* Cpr.

Mitrella granti, new species. Plate 2, fig. 7.

San Felipe, Gulf of California (1933). Type 11383, Lowe collection; paratypes, San Diego Society of Natural History and Academy of Natural Sciences of Philadelphia.

Shell smooth, solid, with seven slightly convex whorls; sutures distinct; axial sculpture entirely absent except inconspicuous lines of growth; the body whorl and the two preceding whorls are covered with regularly spaced spiral grooves with wider interspaces. Color dark brown, somewhat suffused with pale yellow. Aperture rather wide; outer lip slightly undulate; a well marked callus on the straight columella.

Diameter 3.4 mm., altitude 9.4 mm.

This interesting species has been dedicated to Dr. U. S. Grant, of the Department of Geology, University of California at Los Angeles.

Anachis sanfelipensis, new species. Plate 2, fig. 8.

San Felipe, Gulf of California, lower tidal zone (1933). Type 11384, Lowe collection; paratypes, San Diego Society of Natural History and Academy of Natural Sciences of Philadelphia.

Shell solid, turreted, of eight rather flat whorls exclusive of the lost nucleus. Sutures distinct, about thirteen strong axial ribs to the whorl. Entire shell covered with fine microscopic spiral threads. On the back of the columella and base are about eleven strong spiral cords with equal interspaces; above these on the base are about the same number of lighter spiral threads. Body of shell of warm flesh color, with longitudinal blotches of light brown between the axial ribs, and, on the base, wavy longitudinal lines of same color.

Diameter 6.5 mm., altitude 17 mm.

This shell belongs in the same group as *Anachis vexillum* Sby. and *A. fulva* Sby. The former species, which comes from Mazatlan, is a somewhat stouter shell, of much darker color and fewer axial ribs and spiral cords. *A. fulva* Sby., which comes from the Panamic region, is also a broader shell with fewer axial ribs and is of an even light brown color.

Strombina carmencita, new species. Plate 3, fig. 1.

Carmen Island, Gulf of California, dredged 20 fathoms (1932). Type 11375, Lowe collection.

The shell has ten rounded, rapidly enlarging whorls, including two smooth nuclear; the four early whorls almost smooth; on the fifth whorl four spiral cords appear just below the suture, which grow stronger on the body of the last whorl; on the last three whorls are fourteen axial ribs which are obsolete below the periphery of body whorl; entire body whorl covered with wavy spiral threads with about equal interspaces. Color white, slightly mottled with brown, a little darker on the ribs of body whorl. Aperture rather narrowly oblique, with heavily calloused inner and outer lips; canal short and recurved.

Diameter 11 mm., altitude 29.7 mm.

Strombina subangularis, new species. Plate 3, fig. 2.

Carmen Island, Gulf of California, dredged 20 fathoms (1932). Type 11374, Lowe collection.

Shell with acuminate spire, oblong, pyramidal; pale, variegated with brown; eight flattish whorls exclusive of the lost nucleus, ten rather sharp axial ribs, with much wider interspaces, to the whorl; middle of the last whorl gibbously angled, reflected at base; aperture somewhat square, canal long, slightly recurved, lip much thickened, slightly ribbed inside.

Diameter 11.7 mm., altitude 32.2 mm.

This species was subsequently taken in two locations off the Mexican West Coast by the 1933 Crocker Expedition.

The most nearly comparable representative in the group is *S. angularis* Rve. (Conch. Icon., vol. 11, pl. 1, figs. 1a, 1b, 1859), which has four more ribs to the whorl and a much shorter canal.

Turbonilla (Ptycheulimella) penascoensis, new species. Plate 3, fig. 3.

Punta Peñasco, Sonora, dredged 10 fathoms (1934). Type 11588, Lowe collection.

Shell elongate conic, of a warm flesh color, with two yellowish brown spiral bands, the one a little below the suture over twice as wide as the one on the periphery. Nuclear and all post nuclear whorls lacking all axial or spiral sculpture, except the last three, which show very faint microscopic spiral threads visible under a high power lens. There are seventeen rather flat whorls including the nucleus; sutures well appressed, base and aperture well rounded.

Diameter 1.5 mm., altitude 10.4 mm.

Pyramidella (Triptychus) hermosa, new species. Plate 3, fig. 4.

San Felipe, Gulf of California (1933). Type 11376, Lowe collection; cotype, California Academy of Sciences.

Shell small, semiopaque, ivory white. Eight moderately rounded whorls, including the smooth nuclear. Rather strongly tabulated at the shoulders. Sculptured by three strong rounded spiral cords, of which the second and third are stronger than the one just below the suture. In addition to the spiral cords, the whorls are marked by axial ribs which are of about equal strength over the entire shell. Their junction with the spiral cords forms prominent tubercles, which are the outstanding part of the sculpture pattern. There are about thirty-two of these axial ribs on the body whorl. Base moderately rounded, marked with a single spiral cord. Outer lip a little thickened and slightly reflexed. Columella covered with a heavy white callus.

Diameter 2.4 mm., altitude 6.7 mm.

This very interesting species differs considerably in sculpture from *Triptychus olssoni* Bartsch from Santa Elena Bay, Ecuador (Proc. U. S. Nat. Muse., vol. 69, pl. 1, fig. 11, 1926), which seems to be the only other species in this group described from this coast except *Odostomia pedroana* Dall and Bartsch, which was provisionally placed in their new subgenus *Ividella.*

Simnia quaylei, new species. Plate 3, fig. 5.

San Felipe, Gulf of California (1933). Type 11379, Lowe collection; paratypes, San Diego Society of Natural History, University of California at Los Angeles and Academy of Natural Sciences of Philadelphia.

Shell thin, fusiform, swollen at the middle; color a bright shrimp pink; surface polished and glossy; under a lens are seen many fine longitudinal striations; the low spiral cords at either end of the shell appear wavy where crossed by these striations. The callus on the outer lip is not very heavy; aperture rather wide, especially toward the base. There is no trace of an angulated callus on the body whorl side of the aperture, as in *S. aequalis* Sby. and other species.

Diameter 7.8 mm., altitude 23.2 mm.

I have named this finest of all West Coast species of *Simnia* in honor of Mr. E. H. Quayle, who accompanied me on my trip to San Felipe in May, 1933, and who has executed the very excellent drawings for this paper.

Clavus pembertoni, new species. Plate 3, fig. 6.

Angeles Bay, Lower California (1932). Type 11377, Lowe collection; paratypes, San Diego Society of Natural History and Academy of Natural Sciences of Philadelphia.

Shell heavy, turreted, with eleven rounded, strongly nodulous whorls, exclusive of two smooth nuclear whorls. About thirteen nodes on the penultimate whorl, a heavy callosity on back of body whorl. A few strong spiral incised lines are below the periphery of each whorl and on the body whorl extend to the canal. Anal fasciole large, marked with numerous fine incremental lines. Anal sinus very deep; siphonal sinus short and wide. Outer lip slightly thickened and undu-

lated. Columella pillar rather straight, covered with a strong glistening callus. Shell of a deep cream color with a light brown blotch on each node.

Diameter 17.3 mm., altitude 49 mm.

In Dr. R. E. C. Stearns' paper on the shells of the Gulf of California (Proc. U. S. Nat. Muse., vol. 17, p. 172, 1894), he lists a specimen (No. 55239 U. S. N. M.) under the name *Pleurotoma unimaculata* Sby. and compares it with *P. echinata* Lam. and *P. gibbosa* Kiener. I have examined this specimen in the U. S. National Museum and find it to be identical with my specimens of *Clavus pembertoni*. It is quite different from the glistening porcelain white shell of *P. unimaculata* Sby. in color, size and texture.

I take pleasure in dedicating this species to Mr. J. R. Pemberton, owner of the yacht "Petrel" and sponsor of the cruise in 1932 in the Gulf of California.

Elaeocyma acapulcana, new species. Plate 4, fig. 1.

Acapulco, dredged 20 fathoms (1930). Type 11587, Lowe collection.

Shell turreted, acute, smooth, of a delicate flesh color with a pinkish spot on each axial rib at the periphery. There are ten whorls including the smooth nucleus. Suture distinct, slightly undulated by the ribs of preceding whorl; spiral sculpture of sharp, narrow grooves, with much wider, flat, smooth interspaces; there are about twenty of the grooves on the body whorl anterior to the siphonal fasciole; the wide anal fasciole is faintly spirally striate under a high power lens; axial sculpture of about ten straight sharp-edged ribs, with wider interspaces, on the body whorl. Aperture rather wide and short, with a deep, rounded anal sulcus and prominent subsutural callosity; outer lip subvaricose, sharp-edged, smooth within; inner lip with thick layer of enamel; pillar short, straight; canal deep, short, wide, slightly recurved.

Diameter 7 mm., altitude 17 mm.

This shell differs from *Elaeocyma aerope* Dall (Proc. U. S. Nat. Muse., vol. 56, pl. 1, fig. 3, 1920), in having about twice as many spiral grooves on the body whorl, and in the prominently colored peripheral spots on the axial ribs.

Clathrodrillia pilsbryi, new species. Plate 4, fig. 2.

Punta Peñasco, Sonora, dredged 10 fathoms (1934). Type 11587, Lowe collection; paratype, San Diego Society of Natural History.

Shell pale horn-color, with sienna brown blotches between the whitish ribs. There are three smooth nuclear whorls, with nine succeeding whorls; axial sculpture of seven prominent ribs to the whorl, which undulate the well-defined suture. The ribs are obsolete on the base and the wide anal fasciole. The spiral sculpture consists of four or five flat strap-like cords, with wider interspaces, which pass over the periphery and continue over the base. Anal sulcus deep, and prominent anal fasciole smooth, except for strong growth striae; a strong subsutural callus. Outer lip moderately thickened, crenulated by spiral sculpture of the body whorl. Siphonal sinus short, of medium width; columella pillar straight.

Diameter 7.3 mm., altitude 23.5 mm.

This fine species is one of the most interestingly colored and sculptured in the genus, and so far as is now known seems to be confined to the upper end of

the Gulf of California. It has not turned up in any of the numerous dredgings south to Panama.

It is named for Dr. H. A. Pilsbry, of the Academy of Natural Sciences of Philadelphia, in appreciation of his kindly assistance through many years.

(?) **Homalopoma concepcionensis,** new species. Plate 4, fig. 3.

Concepción Bay, Lower California, 15 fathoms (1932). Type 11593, Lowe collection.

Shell small, pure white, solid, globose, suture strongly appressed; five whorls, including the smooth nucleus, strongly tabulated by a peripheral keel. On the penultimate whorl is a strong sutural keel and two almost equally strong just below it; on the flat shoulder just anterior to the major keel are three secondary flat spiral cords with wide interspaces. On the body whorl, just below the suture, are two major spiral cords with a secondary spiral thread between; next three of the strong cords with four spiral threads anterior to each; posterior to the last are thirteen flattened spiral cords of about equal strength and equal interspaces. The entire surface between the spiral sculpture is covered with microscopic, diagonally radial striae. Aperture circular, outer lip thin; heavy callus on the columella, back of which is a large, flattened chink with four radial threads on its flat surface.

Diameter 5.6 mm., altitude 5.6 mm.

As there was no sign of an operculum attached to the animal, I am in doubt whether to place the species in *Homalopoma* or *Liotia.* In Dall's paper on the Florida Fossils (Trans. Wagner Free Inst. Sci., vol. 3, Aug., 1890) is a species which is certainly congeneric—very similar in form and sculpture, and even in having the same umbilical chink with four radial threads. Dall has placed the shell with a question in *Gibbula,* as *G. americana* Dall (Plate 22, fig. 32).

Hemitoma hermosa, new species. Plate 4, fig. 4.

Carmen Island, Gulf of California, 20 fathoms (1932). Type 11385, Lowe collection.

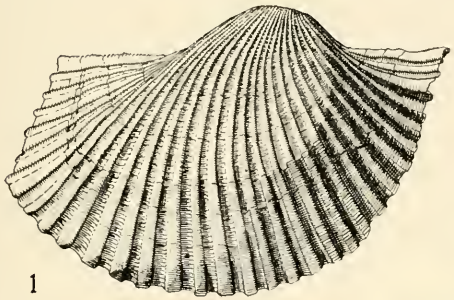
Shell small, thin, oblong oval, much elevated, narrowest anteriorly; apex posterior, prominent and somewhat recurved; outline in front of apex slightly convex, from apex to the posterior margin slightly excavated, sides descending nearly straight; sinus moderate, situated at the extremity of a prominent, strongly nodulous rib. Three slightly less prominent, but nodulous ribs on either side, with weaker ribs between, giving the margin of the shell a crenulated appearance. Inside of the shell is a glossy horn color, outside chalky of a lighter shade.

Diameter 7.3 mm., breadth 5 mm., altitude 4.7 mm.

Fusinus fredbakeri, new species. Plate 4, fig. 5.

San Felipe, Gulf of California (1933). Type 11590, Lowe collection; paratypes, San Diego Society of Natural History and California Academy of Sciences.

Shell with six well-rounded, strongly sculptured whorls exclusive of the nuclear whorls. Axial sculpture, on the penultimate whorl, of twelve rounded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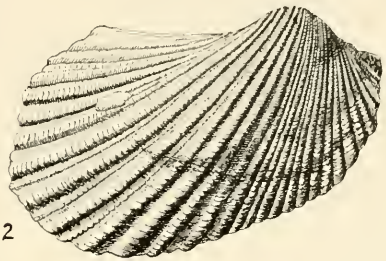
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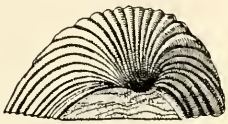
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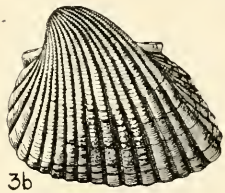
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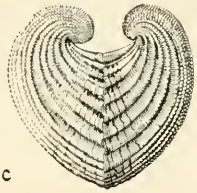
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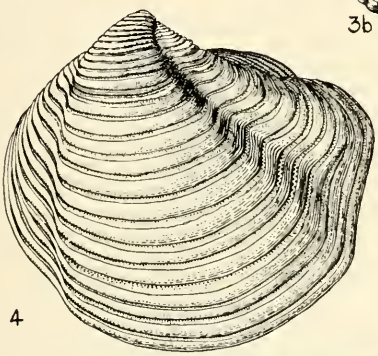
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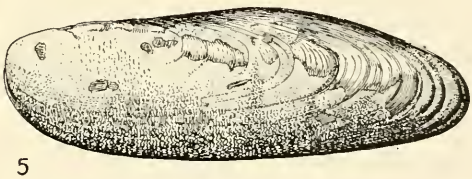
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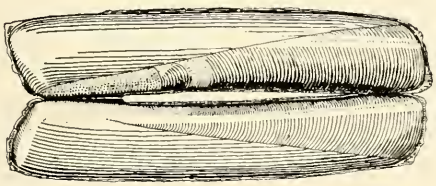
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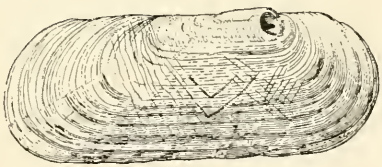
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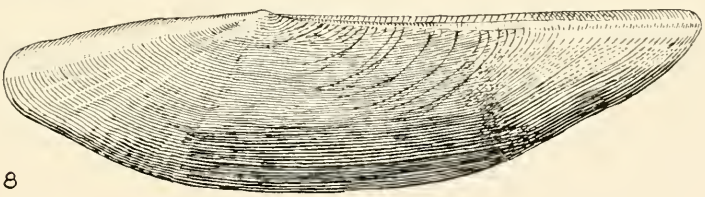
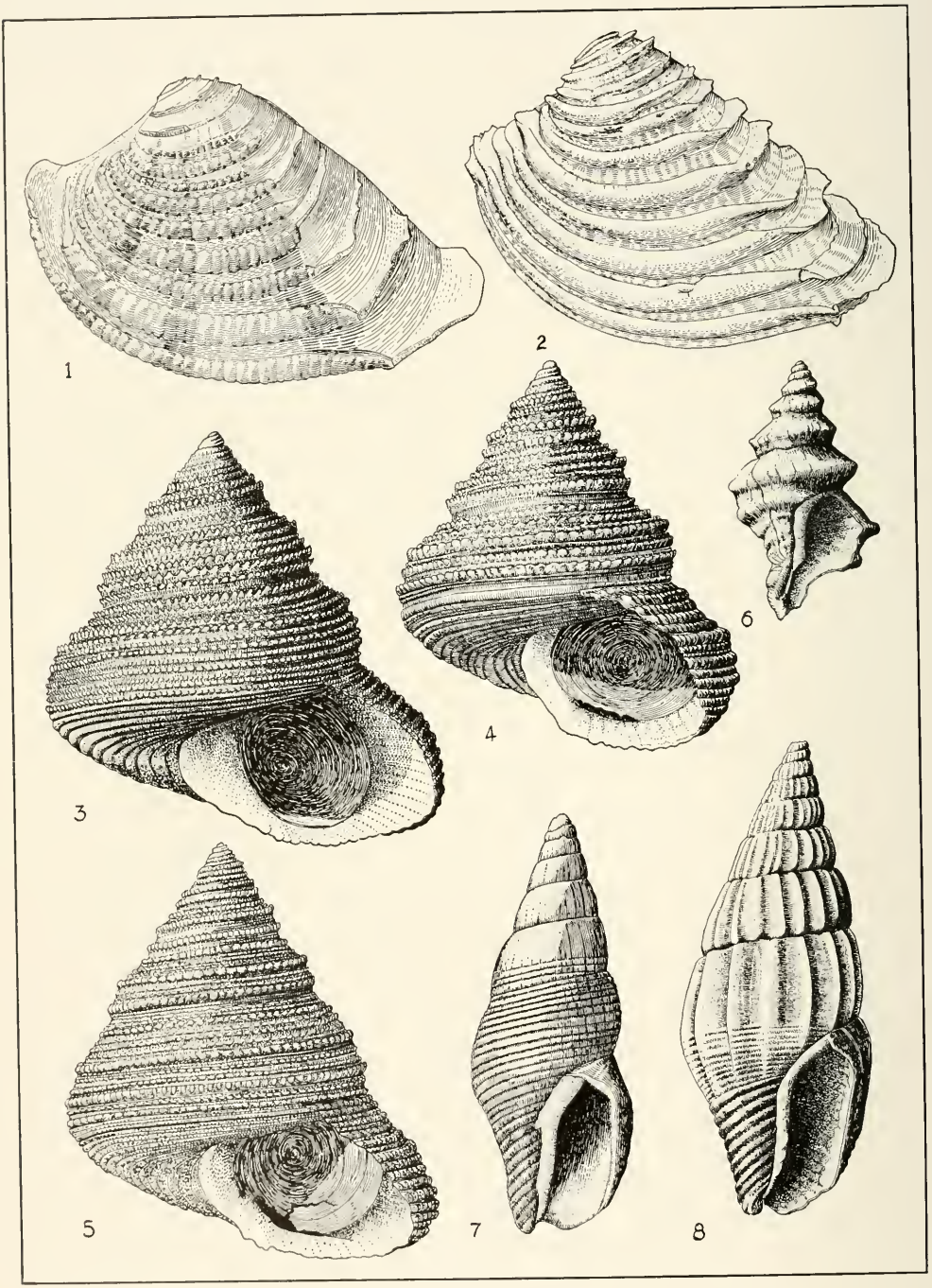
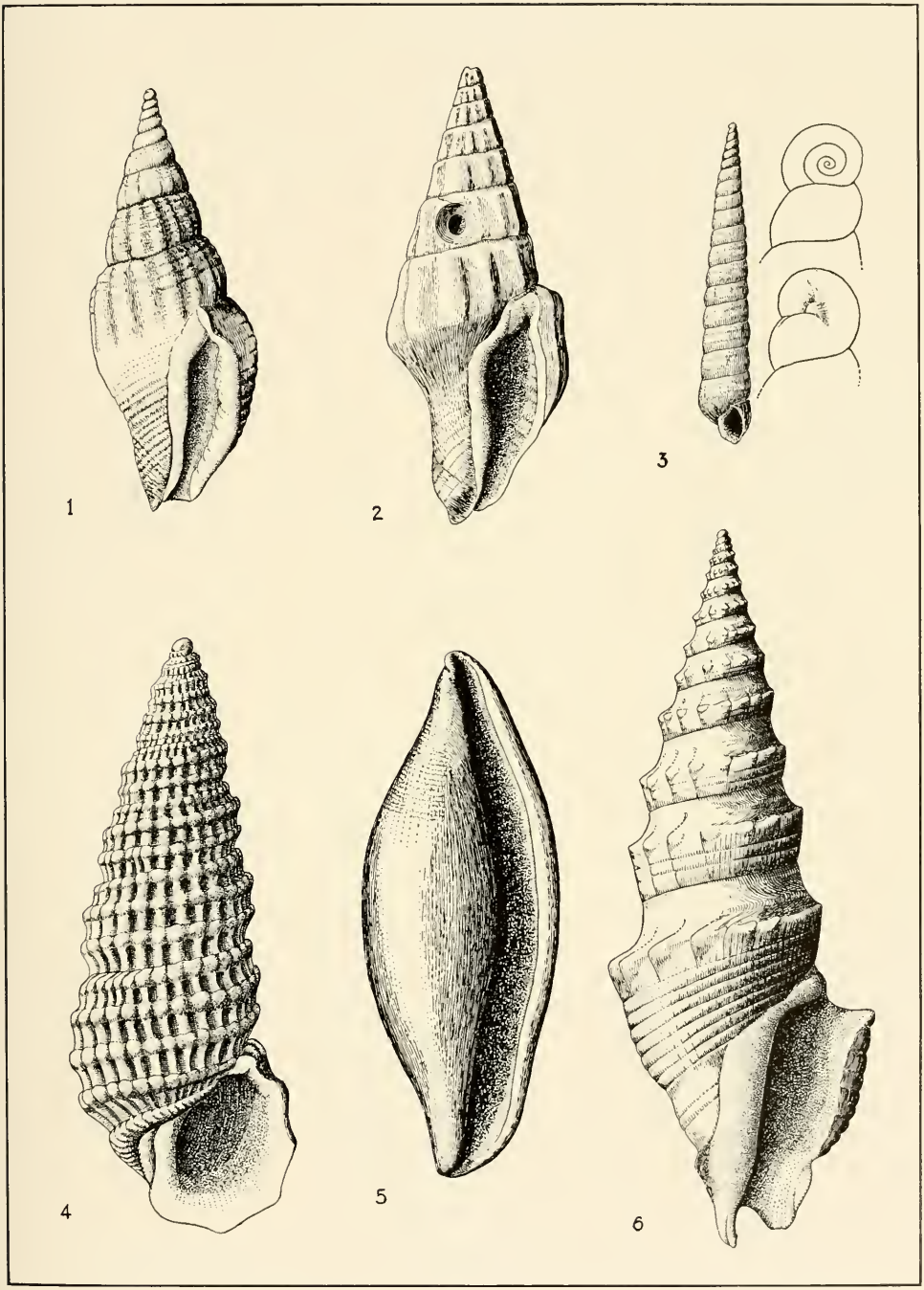

8

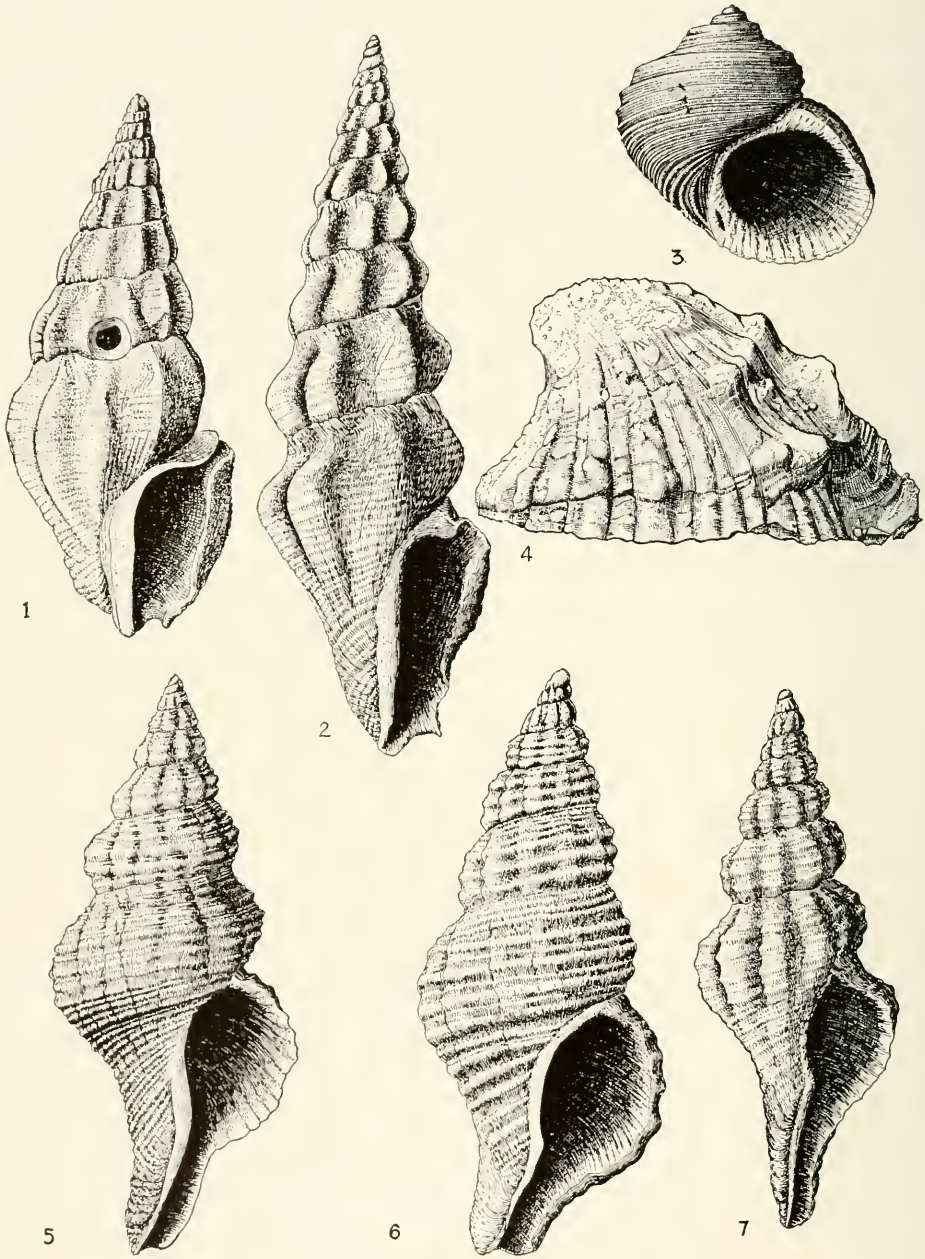
1. Arca gordita n. sp.
2. Arca delgada n. sp.
3a, b, c. Arca (Anadara) reinharti n. sp.
4. Phacoides (Pleurolucina) leucocymoides n. sp.
5. Lithophaga abbotti n. sp.
6. Solen pazensis n. sp.
7. Psammosolen guaymasensis n. sp.
8. Leda (Adrana) penascoensis n. sp.



1. Venus kellettii Fbs.
2. Venus mariae Orb.
3. Calliostoma marshalli n. sp.
4. Calliostoma gemmuloides n. sp.
5. Calliostoma angelenum n. sp.
6. Tritonalia carmen n. sp.
7. Mitrella granti n. sp.
8. Anachis sanfelipensis n. sp.



1. **Strombina carmencita** n. sp.
2. **Strombina subangularis** n. sp.
3. **Turbonilla (Ptycheulimella) penascoensis** n. sp.
4. **Pyramidella (Triptychus) hermosa** n. sp.
5. **Simnia quaylei** n. sp.
6. **Clavus pembertoni** n. sp.



1. Elaeocyma acapulcana n. sp.
2. Clathrodrillia pilsbryi n. sp.
3. (?) Homalopoma concepcionensis n. sp.
4. Hemitoma hermosa n. sp.
5. Fusinus fredbakeri n. sp.
6. Fusinus felipensis n. sp.
7. Fusinus hertleini n. sp.

ribs, with about equal interspaces, most prominent on the periphery. There are eight or nine spiral cords of unequal strength on the penultimate whorl. The type specimen is of a deep cream color, on other specimens shaded to a warm sienna brown. Canal straight, narrow and of medium length, aperture broadly rounded; outer lip thin, crenulated by the spiral sculpture, which shows through on the inside.

Diameter 15.5 mm., altitude 38 mm., 7 whorls, 12 varices.

In all stages of growth this shell is much broader than *F. ambustus* Gld., measurements of which are diameter 13.3 mm., altitude 38 mm., 8 whorls, 10 varices. It also has more, although less prominent, axial ribs. It is named in honor of my good friend Dr. Fred Baker, of San Diego, who has done so much valuable work in West Coast Conchology and whose kindly assistance and advice to me have been of great help.

Fusinus felipensis, new species. Plate 4, fig. 6.

San Felipe, Gulf of California (1933). Type 11589, Lowe collection; paratypes, San Diego Society of Natural History and California Academy of Sciences.

Shell small, purplish brown, nearly the same size as the average *Fusinus luteopictus* Dall of the upper California coast. There are seven rounded whorls, including the smooth white nucleus. There are eleven axial ribs with somewhat wider interspaces on the penultimate and ten on the antepenultimate whorl, which are continuous from suture to suture; they gradually fade out on the body whorl. There are four or five strong, spiral cords to the whorl, with a weaker spiral thread between, which render the axial ribs nodulous. Aperture oval, of a purplish color; outer lip thin, slightly crenulated by the spiral sculpture; inside smooth; canal straight, of medium length and width.

Diameter 7.7 mm., altitude 19.2 mm.

Fusinus hertleini, new species. Plate 4, fig. 7.

Concepción Bay, Lower California (1932). Type 11592, Lowe collection; paratypes, San Diego Society of Natural History and California Academy of Sciences.

Shell elegantly and regularly fusiform, of six or seven well rounded whorls. On the body whorl are eleven or twelve rounded axial costae, which become obsolete below the periphery, crossed by three strong, spiral cords and several lesser spiral threads; canal straight and narrow; aperture suboval; outer lip slightly crenate at the margin. Color sienna brown with cream-colored costae.

Diameter 15.1 mm., altitude 41.1 mm.

At Sargent's Point on the Sonora coast, off the north end of Tiburón Island, I collected a form entirely cream-colored, except two or three post-nuclear whorls which show the brown blotches between the costae. This may take the name of variety *albescens.*

At the same locality I collected another form with wide white subperipheral band on body whorl and a narrow dark brown band just below. This may be known as variety *bruneocincta.*

The new species has more prominent axial ribs than *Fusinus ambustus* Gld., which has sharper spiral sculpture. It also has two more axial ribs to the whorl than *F. ambustus*.

The shell is named in honor of Dr. L. G. Hertlein, of the California Academy of sciences, who has been studying the West Mexican molluscan faunas for a number of years.

Fusinus cinereus (Reeve) and varieties

Specimens of a *Fusinus* collected by me at La Paz and also at Guaymas match the figure given by Reeve for his *Turbinella cinerea*[2] so closely that I do not hesitate to identify them as typical examples of his species. Since Reeve's *cinerea* was described under the genus *Turbinella* and Say's earlier *Fusus cinereus*[3] under *Fusus* (a group generally known as *Fusinus*, though Say's *cinereus* is really a *Urosalpinx*), it does not seem advisable to consider Reeve's specific name a homonym. The two species bear the same specific name, but were described under different genera and actually are not congeneric or even members of the same family.

The present species, *Fusinus cinereus* Reeve (olim *Turbinella id.*) is probably the species which Dall[4] once identified as *F. taylorianus* Reeve,[5] but in all my collecting I have never encountered a west coast shell which I could identify unquestionably as *taylorianus*, and I believe that Dall must have overlooked Reeve's *cinereus* because it was included in *Turbinella*.

On the Coronado Island in the Gulf of California I collected a smaller, lighter colored form of *Fusinus cinereus* Reeve with white axial ribs. This may take the varietal name of *coronadoensis*.

On the Sonora coast, north from Guaymas to Sargent's Point (opposite the north end of Tiburón Island), I collected in several localities an almost black form, with only the first three whorls showing white on the axial ribs. This color form may be known as variety *sonoraensis*.

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[2] Conch. Icon., vol. 4, *Turbinella,* pl. 13, fig. 68, 1847.

[3] Acad. Nat. Sci. Philadelphia, Journ., vol. 2, p. 236, 1822.

[4] Nautilus, vol. 29, no. 5, p. 55, 1915.

[5] Conch. Icon., vol. 4, *Fusus,* pl. 20, fig. 85, 1848, (unknown habitat).

AN ANNOTATED LIST OF SHELLS COLLECTED AT PUNTA PENASCO, SONORA, MEXICO, IN FEBRUARY, 1934

BY

HERBERT N. LOWE

San Diego Society of Natural History

BIVALVES

Solemya panamensis Dall — 10 fathoms, dredged.
valvulus Cpr. — a single example of each dredged in 10 fathoms; gray mud.

Nucula declivis Hds. — many valves taken at 10 fathoms.

Leda impar Pils. and Lowe — a few pairs and many valves at 10 fathoms.
leviradius Pils. and Lowe — four pairs only at 10 fathoms.
(Adrana) penascoensis Lowe — the type and a damaged paratype at 10 fathoms; mud.

Glycimeris maculata Brod. — a large colony at low tide near Punta La Cholla in coarse gravely sand. Many valves found in Indian kitchen middens near by.
gigantea Rve. — a single beach valve only.
multicostata Sby. — many young valves brought up in dredge at 10 fathoms.

Arca alternata Sby. — valves only taken in dredge at 10 fathoms.
gradata B. and S. — valves only taken with preceding species.
illota Sby. — living examples not rare under rocks.
pacifica Sby. — one pair only, although plentiful in kitchen middens.
reeveana Orb. — three pairs taken under rocks.
reinharti Lowe — valves only at 10 fathoms.
solida B. and S. — common living under rocks.

Pinna rugosa Sby. — several very young pairs on beach.
maura Sby. — several very young pairs on beach.

Pteria peruviana Rve. — three young pairs washed in attached to sea fans. Many large valves in kitchen middens.

Melina (Pedalion) chemnitziana Orb. — common under rocks.
(Pedalion) anomioides Rve. (=**janus** Cpr.) — not rare under rocks.

Ostrea chilensis Phil. — a few attached to rocks at half tide.
palmula Cpr. — fairly plentiful with preceding species.
dalli Lamy (=**serra** Dall) — a few valves brought up in dredge at 10 fathoms.

Pecten circularis Sby. — beach valves and a few very young brought up in dredge.

Lima pacifica Orb. — a few living pairs under rocks, extreme tide.
orbignyi Lamy — a few beach valves only.

Anomia peruviana Gray — two beach valves only.

Mytilus adamsianus Dkr. — not common.
multiformis Cpr. — abundant in rock crevices at half tide, though not in such profusion as at San Felipe.

Modiolus capax Conr. — a few good pairs washed up.
guyanensis Lam. (=**braziliensis** Chem.) — plentiful living in sandy mud flats.

Gregariella denticulata Dall — a few good pairs.

Lithophagus attenuata Desh. — boring in ledges of fossiliferous sandstone.
aristata Dill. — with preceding species, but more abundant.

Crenella divaricata Orb. — a few valves in dredge.

Thracia curta Conr. — a few perfect pairs.
squamosa Cpr. — one young pair dredged at 10 fathoms.

Pandora claviculata Cpr. — several fragments dredged.

Lyonsia inflata Conr. — on reefs with ascidians.
sp. ? — dredged at 10 fathoms.

Cuspidaria didyma Hds. — a few pairs dredged.
dulcis Pils. and Lowe — six valves only dredged.

Crassatellites gibbosus Rve. — odd valves and a few very young examples dredged.

Cardita affinis var. **californica** Desh. — very large and abundant under rocks at half tide.

Chama buddiana C. B. Ads. — one pair only; common in the Indian kitchen middens.
echinata Brod. — beach valves; abundant in kitchen middens.

Diplodonta subquadrata Cpr. — a few valves.

Felaniella serricata Rve. — not common.

Divaricella eburnea Rve. — valves brought up in dredge.

Codakia distinguenda Tryon — beach specimens not rare.
mexicana Dall — dredged at 10 fathoms.
chiquita Dall — odd valves plentiful with foregoing species.

Phacoides cancellaris Phil. — odd valves in dredge.
mazatlanicus Cpr. — odd valves in dredge.
nuttallii var. **centrifugus** Dall — odd valves in dredge.
(Cavilucina) lamprus Dall — a few beach valves.

Cardium (Papyridea) aspersum Sby. — beach valves only.
(Fragum) biangulatum Sby. — a few pairs brought up in dredge.
(Laevicardium) elatum Sby. — young shells in dredge and a few full grown valves on beach.
(Laevicardium) elenensis Sby. — a few in dredge.
(Trigonicardia) graniferum B. and S. — many valves in dredge.
(Bingicardium) procerum B. and S. — good pairs on tide flats.

Dosinia dunkeri Phil. — a few fresh pairs.
ponderosa Gray — single valves abundant on beach.

Tivela delesserti Desh. — rare living on sand flats at low tide.

Chione fluctifraga Val. — living on mud flats.
succincta Val. — with preceding species.
purpurascens Dall — one beach valve only.
mariae Orb. — odd valves plentiful in dredge.

Macrocallista squalida Sby. — a few beach pairs.

Pitar concinna Sby. — a few valves in dredge.
newcombiana Gabb — valves only in dredge.

Paphia grata Sby. — plentiful in sand between small stones near mouth of estuary.

Cyclinella singleyi Dall — one pair and a few valves in dredge.

Petricola denticulata Sby. — not rare in fossiliferous limestone reefs.
robusta Sby. — seemingly a rare species; only two pairs taken with preceding species.

Metis excavata Sby. — one beach valve only.

Tellidora burneti B. and S. — valves only in dredge.

Tellina crystallina Chem. — valves only in dredge.

Macoma panamensis Dall — valves in dredge.
(Cymatoica) undulata Hanley (=**occidentalis** Dall) — many valves at 10 fathoms.
indentata Conr. — many pairs on mud flats.

Tellina simulans C. B. Ads. — odd valves on beach.
(Moerella) meropsis Dall — dredged at 10 fathoms.
(Moerella) reclusa Dall — dredged at 10 fathoms.
(Angulus) amianta Dall — dredged at 10 fathoms.

Semele flavescens Gld. — three beach specimens.
guaymasensis Pils. and Lowe — a few pairs in dredge.
pacifica Dall — odd valves only in dredge.
sp. ? — one valve only in dredgings.

Donax gracilis Hanley — living on sand flats.
navicula Hanley — living on sand flats.

Heterodonax bimaculatus Orb. — beach valves.

Tagelus affinis C. B. Ads. — plentiful on mud flats.

Psammosolen guaymasensis Lowe — two valves dredged at 10 fathoms in mud.

Solen rosaceus Cpr. — two pairs only on sand flats.

Mactra dolabriformis Conr. — a single beach valve.
californica Conr. — valves in dredge.

Sphenia fragilis Cpr. — two pairs only.

Corbula marmorata Hds. — a few in dredge.
nasuta Sby. — plentiful in dredgings.
bicarinata Sby. — a single pair under a rock.
sp. ? — odd valves in dredge.

Solecardia eburnea Conr. — one valve in dredge.

Crassinella varians Cpr. — valves plentiful in dredge.

UNIVALVES

Dentalium inversum Desh. — dredged at 10 fathoms.
fisheri Stearns — dredged at 10 fathoms.
splendidum Sby. — dredged at 10 fathoms.
numerosum Dall — dredged at 10 fathoms.

Cadulus panamensis Sby. — dredged at 10 fathoms.

Retusa paziana Dall —— dredged at 10 fathoms.
gonzagensis Baker and Hanna — dredged at 10 fathoms.

Volvulella californica Dall — dredged at 10 fathoms.

Acteocina infrequens C. B. Ads. — dredged at 10 fathoms.

Bulla gouldiana Pils. — several taken living in sand pockets in reefs.

Haminea virescens Sby. — one specimen.

Terebra bridgesi Dall — a few in dredge at 10 fathoms.
larvaeformis Hds. — dredged at 10 fathoms.
sp. ? — dredged at 10 fathoms.
sp. ? — dredged at 10 fathoms.
sp. ? — dredged at 10 fathoms.
sp. ? — dredged at 10 fathoms.

Turritella goniostoma Val. — dredged at 10 fathoms.
tigrina Kiener — dredged at 10 fathoms.

Conus interruptus Brod. — a fine colony of extra large specimens taken in gravely sand with *Glycimeris maculata.*
puncticulatus Hws. — a few in dredge.
regularis Sby. — a few live ones on mud flats.

Turris olivacea Sby. — a number taken living on reef.
tuberculifera Brod. and Sby. — two beach specimens only taken of this very rare form.

Crassispira bottae Val. — two living specimens taken on reef, in sand pockets; an exceedingly rare species.
nymphia Pils. and Lowe — four taken on reef.
nigerrima Sby. — a few in the 10 fathom dredgings.
pluto Pils. and Lowe — abundant living on moss-covered rocks of reef.

Clathrodrillia halis Dall — dredged at 10 fathoms; not rare.
alcestis Dall — dredged at 10 fathoms.
thestia Dall — dredged at 10 fathoms.
callianira Dall — dredged at 10 fathoms.
rosea Sby. — one fine specimen in dredgings.
pilsbryi Lowe — a few in dredgings.

Elaeocyma unimaculata Sby. — dredged at 10 fathoms.
aeolia Dall — dredged at 10 fathoms.
ianthe Dall — dredged at 10 fathoms.
palmeri Dall — dredged at 10 fathoms.
sp. ? — dredged at 10 fathoms.

Glyphostoma adria Dall — a few choice specimens.

Cytharella phaethusa Dall — a single shell dredged.

Mangelia arteaga roperi Dall — a few dredged at 10 fathoms.
antipyrgus Pils. and Lowe — a few dredged at 10 fathoms.
cymatias Pils. and Lowe — a few dredged at 10 fathoms.

Cancellaria cassidiformis Sby. — a few beach specimens.
obesa Sby. — two beach specimens.
funiculata Hds. — one dredged living at 10 fathoms.

Oliva incrassata Sol. (=**angulata** Lam.) — fine large ones living with *Conus interruptus* at low tide.
polpasta Duclos — dredged; this species seems to live only in deep water.

Olivella dama Gray — abundant in sand pockets in reefs.
zonata Duclos — very rare on beach; living.
gracilis B. and S. — taken in dredge.

Agaronia testacea Lam. — many fine specimens taken living on sand beach at half tide.

Marginella californica Tomlin — not rare, under stones.

Mitra attenuata Rve. — a few fine specimens dredged.
dolorosa Dall — a single example taken on reef.

Latirus lugubris C. B. Ads. — three specimens from reef.

Galeodes patula Brod. — beach specimens.

Hanetia pallida Brod. and Sby. — abundant on reef.

Fusinus dupetithouarsi Petit — a number of young specimens in dredge.
felipensis Lowe — several live specimens under rocks.

Nassa iodes Dall — many living in sand flats.
leucops Pils. and Lowe — abundant in sandy mud.
tiarula Kiener — a few taken on sand flats.
pagoda Rve. — dredged at 10 fathoms.
versicolor C. B. Ads. — taken alive in sand pockets in reef.
versicolor striatula C. B. Ads. — with preceding species.
angulicostis Pils. and Lowe — dredged at 10 fathoms.

Anachis coronata Sby. — living specimens under rocks.
hilli Pils. and Lowe — four living specimens under rocks.
vexillum Rve. — four living specimens under rocks.
varia Sby. — four living specimens under rocks.

Columbella fuscata Sby. — common under rocks.
major Sby. — not common.

Mitrella diminuta C. B. Ads. — a few of this tiny species.
ocellata var. **guttata** Sby. — common under rocks.

Strombina dorsata Sby. — dredged at 10 fathoms.
gibberula Sby. — dredged at 10 fathoms.
maculosa Sby. — dredged at 10 fathoms.

Parametaria dupontii Kiener — a few living under rocks.

Cosmioconcha palmeri Dall — two specimens in dredge.

Phos veraguensis Hds. — two young in dredge.
mexicanus Dall — a number of fine specimens in dredge.

Murex elenensis Dall (=**plicatus** Sby.) — beach shells only.

Phyllonotus bicolor Val. — many fine specimens feeding on bivalves on sand beach at very low tide.
nigritus Meusch. — abundant on reefs feeding on *Cerithium stercus-muscarum*.

Acanthina angelica Oldroyd—very abundant living on exposed wave-beaten rocks.
muricata Brod. — very good examples taken on reefs.

Thais triserialis Blv. — a few taken on reef.

Muricopsis erynaceoides Val. — a few taken in dredge.

Eupleura muriciformis Brod. — some good specimens taken with dredge.
triquetra Rve. — not rare on reefs feeding on *Cerithium;* a few were yellow and some almost white.

Epitonium crenimarginata Dall — three beach specimens.
crenatoides Cpr. — one dredged.
(Asperoscala) canna Dall — two dredged.
bialatum Dall — two dredged.
sp. ? — two dredged.

Melanella mexicana Dall — dredged at 10 fathoms.
rutila Cpr. — one dredged at 10 fathoms.

Strombiformis lapazana Bartsch — four dredged at 10 fathoms.
townsendi Bartsch — one dredged at 10 fathoms.

Niso excolpa Bartsch — a few fine examples dredged.

Turbonilla ceralva Dall and Bartsch — dredged at 10 fathoms; 3 specimens.
mayana Baker, Hanna and Strong — dredged at 10 fathoms.
calvini Dall and Bartsch — dredged at 10 fathoms.
sanctorum Dall and Bartsch — dredged at 10 fathoms.
pazana Dall and Bartsch — dredged at 10 fathoms.
penascoensis Lowe — dredged at 10 fathoms.
azteca Baker, Hanna and Strong — several dredged at 10 fathoms.
subangulata Cpr. — three specimens dredged.
macbridei Dall and Bartsch — dredged at 10 fathoms.

Pyramidella mazatlanica Dall and Bartsch — a few dredged at 10 fathoms.
bicolor Dall and Bartsch — a few dredged at 10 fathoms.

Odostomia telescopium Cpr. — dredged at 10 fathoms.
convexa Cpr. — six specimens dredged.
gabrielensis Baker, Hanna and Strong — two specimens dredged.
effusa Cpr. — several dredged.

Cypraea annettae Dall (=**sowerbyi** Kiener) — some fine living specimens under rocks.

Trivia solandri Gray — many specimens taken feeding on upper side of moss-covered rocks.
californica Gray — a few taken with preceding species.

Cymatium adairensis Dall — a few taken alive in crevices of rocks; a rare form. Nearly topotypes, as Adair Bay is only a few miles north of Punta Peñasco.

Cerithiopsis sp. ? — three specimens in dredge.

Alabina diomedeae Bartsch — common in dredgings.

Seila assimillata C. B. Ads. — several taken living on under side of old valves of *Dosinia ponderosa* on reef.

Cerithium maculosum Kiener — living in sand pockets in reefs.
incisum Sby. — common living under rocks.
stercus-muscarum Val. — thousands living on reefs at half tide.

Cerithidea mazatlanica Cpr. — abundant on mud flats.

Caecum firmatum Cpr. — common in dredgings.
liratocinctum Cpr. — common in dredgings.

Vermetus pellucidus Brod. — a few under rocks.
tripsycha Pils. and Lowe — one beach specimen.

Rissoina barthelowi Bartsch — four crab specimens dredged at 10 fathoms.
mexicana Bartsch — four specimens dredged at 10 fathoms.

Hipponyx barbatus Sby. — extra fine specimens with lower plate developed into a deep concave valve; taken on outer reefs.
serratus Cpr. — under rocks at low tide.

Calyptraea mamillaris Brod. — dredged at 10 fathoms.
conica Brod. — dredged at 10 fathoms.

Crucibulum spinosum Sby. — a few in dredge.

Crepidula arenosa Brod. — half grown specimens in dredge.
onyx Sby. — one beach specimen.
nivea Gld. — one beach specimen.

Natica marochiensis Gmel. — two living specimens on mud flats.

Polinices bifasciatus Gray — extra large specimens taken in sandy gravel with *Glycimeris maculata.*
uber Val. — living specimens taken on sand flats.
recluzianus Petit — young specimens in dredge.

Lamellaria diegensis Dall — a number taken alive with ascidians on beach after storm.

Acmaea mesoleuca Menke — abundant on rocks at half tide.
mitella Menke — not common; almost at high tide; a very tiny species.

Turbo fluctuosus Wood — plentiful under rocks.
Leptothyra concepcionensis Lowe — one specimen dredged.
Liotia carinata Cpr. — several in dredgings at 10 fathoms.

Tegula globulus Cpr. — abundant under stones in same zone as *A. mesoleuca.*
rugosa A. Ads. — extra large specimens taken on upper side of rocks.
mariana Dall — a few good living specimens taken under rocks at low tide.

Calliostoma palmeri Dall — a few in dredgings.
marshalli Lowe — a single example dredged.

Circulus annulatus Cpr. — dredged at 10 fathoms.
tricarinatus C. B. Ads. — dredged at 10 fathoms.

Neritina picta Sby. — plentiful on rocks at mouth of estuary.

Nerita scabricosta Lam. — on rocks near high tide.
bernhardi Recl. — on rocks near high tide.

Strombus galeatus Sby. — half grown specimens on mud flats.

Diadora alta C. B. Ads. — four specimens taken under rocks at low tide.
inaequalis Sby. — not rare under rocks.

Ficus decussatus Wood — three fair beach specimens.
Cassis abbreviatus Lam. — several beach specimens.
Heliacus radiatus Mke. — two crab specimens under rocks.
Aplysia sp. ? — the animal looks much like our *californicus.*
Chiton virgulatus Sby. — abundant under rocks.

Ischnochiton acrior Cpr. — plentiful under rocks.
clathratus Rve. — plentiful under rocks.
(Stenoplax) limaciformis Sby. — five specimens on reef.

Callistochiton infortunatus Pils. — not common under rocks.
sp. ? — a beautiful color series taken on reef.
sp. ? — a few taken on reef; both this and preceding species were taken in 1933 at San Felipe.

Acanthochites diegensis Pils. — three specimens on reef.
Dendrochiton sp. ? — three specimens on reef; similar to *D. thamnophora* Berry.
Nuttallina sp. ? — a very small species; taken on outer rocks.

28,898

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

Vol. VIII, No. 7, pp. 35-46, plate 5 March 21, 1935

NEW SPECIES OF MOLLUSKS OF THE GENUS TRIPHORA

BY

Fred Baker and V. D. P. Spicer

San Diego Society of Natural History

This report covers seven species of the genus *Triphora* which seem to be new. Five species were collected in 1927 by Mr. Wray Harris, of the U. S. Navy, on the outer edge of the coral reefs surrounding the Island of Ofu of the American Samoan Group at low tide levels and where they were subject to the full force of the wave movement. The other two species were collected in 1896 by the late Capt. Geo. D. Porter for the late Miss Jeannette M. Cooke of San Diego, who maintained a small collecting vessel on the coast of Lower California and in the Gulf of California under command of Capt. Porter for many years. These shells were taken during Capt. Porter's final disastrous trip, when he and his companion were murdered on Tiburón Island by the Seri Indians. The specimens were labeled as from the Gulf of California, but, as Capt. Porter made most of his collections of minute shells from Espíritu Santo Island near the southern end of the Gulf, it is extremely probable that they came from that locality.

Our sincere thanks are due to Mr. Wray Harris for kindly allowing us to describe and figure the Samoan species, and to Mr. E. M. Thorp of the Scripps Institution of Oceanography at La Jolla for making the microphotographs illustrating the paper.

TRIPHORA (Deshayes) Blainville, 1828

In the discussion of this genus, Tryon (Man. Conch., IX, 121) says "An anomaly of the shell is the occasional preservation of a second

canal upon the back of the body whorl, showing the termination of a former aperture. This is present in the fossil species upon which Deshayes established his genus,[1] and which is named from this character. * * * Having examined several species with three apertures I incline to the opinion that the posterior canal is only accidentally preserved in some cases by reason of its deflection, which causes its tube to be surrounded with shelly matter during the growth of the shell, and that it bears no relation to the economy of the animal. This view is fortified by the consideration that neither in this group nor in any other group of the mollusca are we acquainted with any organ which might occupy or occasion this tube for the purpose of its economy. Moreover, in one of the species before me two individuals possess the third opening, whilst two others have it not."

In a large suite of *Triphora violacea* Quoy taken on Ofu by Mr. Harris, most of the specimens show the third opening or meatus noted above. In a few specimens it is missing and all of these are immature. The series shows the posterior canal in the usual position within the aperture, open as is common in most species of univalves; partially enclosed and, finally, as a completed tube. It is evident that when the shell is within half a turn of maturity, the animal proceeds to change the open canal to the tubular form which, with the advancement of the outer lip through additions, is left further and further from the outer lip until it reaches a position opposite the aperture, where it remains permanently. Such specimens show no sign of the open posterior canal within the aperture. The series shows every stage of this process up to the point where, having taken its permanent place, the animal proceeds to build the outer lip and aperture into final shape. Some species show this process to have taken place in nearly all, or all, mature specimens, while in other species of which we have large suites, the process does not take place at all. No specimen of *T. abbotti* or of *T. granti* of this paper shows any sign of the tubulation of the posterior canal.

While the question cannot be settled finally until careful examinations of living animals can be made, the writers differ radically from Tryon's dictum and believe that the third opening, when present, has a very decided "relation to the economy of the animal." We believe it will be shown that, as the posterior canal is thus left behind, the excretory

[1] A reference to a description in 1825 under a vernacular name without validity under the Code.

siphon also remains stationary within the canal while a half turn is added to the shell, so that the third opening does service for the rest of the life of the animal as an excretory meatus. We wonder that Tryon forgot that a similar process takes place in *Haliotis,* in which the notch on the edge of the shell is finally sealed as a round hole. This hole and the enclosed excretory siphon remain stationary as additions are made to the edge of the shell and new holes are added. Finally, from being the newest hole it is left to the oldest and, later, is closed by the deposition of new shell material and the corresponding excretory siphon atrophies.

As to the same species showing specimens with and without the third opening as noted by Tryon, it seems most probable that two specimens were immature, not having begun the formation of the body whorl, in which case the posterior canal would be open and within the aperture. The other two specimens were evidently mature, showing the posterior canal in its normal position opposite the aperture, in which case there would be no sign of a posterior canal within the aperture.

Triphora harrisi Baker and Spicer, new species

Plate 5, figs. 1-2

Shell sinistral, of medium size, spindle-shaped; nuclear whorls four, straw-yellow, the first nearly smooth, rounded and shining, the others bearing a single prominent, spiral subcarinate cord, slightly concave below the carina, the carina doubled on the final nuclear whorl, crossed by numerous, prominent vertical ribs forming deep pits at the sides of the carinae and in the space formed by the doubling of the carina of the fourth whorl; postnuclear whorls eleven, white, polished and shining; transition of color and sculpturing abrupt to two low spiral cords, each bearing a row of nearly round tubercles, the anterior cord more prominent up to the last turn, where the posterior cord becomes more prominent; sutural channel narrow, slightly sinuous; median channel smooth except for incremental lines, not crossed by vertical riblets, rendered sinuous by the placement of the upper tubercles opposite the lower interspaces; tubercles appearing as two parallel rows of shining beads immersed in the shell structure rather than as if formed by the intersections of axial ribs and spiral cords; median channels of the lower whorls slightly tinted with brown; a weak, nodular peripheral keel margining the aperture; base irregularly convex, faintly brown, bearing two tuberculate cords, the posterior about equalling the peripheral cord, the anterior weaker and smoother, continuing for about half a turn and ending abruptly behind the outer lip; aperture round, tubular, extending radially beyond the periphery of the shell, smooth and pearly within, wrinkled and lined externally; anterior canal short, tubular, nearly straight, projecting in the axis of the shell; a third meatus opposite the aperture projecting as a round tube about 0.25 mm. beyond the periphery of the shell; no posterior canal showing within the aperture.

Length, 5.5 mm.; diameter, 1.75 mm.

Holotoype: No. 23761, collection of the San Diego Society of Natural History, and ten paratypes; collected by Mr. Wray Harris on the coral reefs of Ofu, Samoa. Paratypes in the U. S. National Museum and in the collections of Mr. Harris, for whom the species is named, and of the authors. The species seems to be new and distinct from any other species of the region except the succeeding one.

Triphora ofuensis Baker and Spicer, new species

Plate 5, fig. 3

Shell sinistral, minute, spindle-shaped; nuclear whorls five, light brown, postnuclear whorls seven, white; first nuclear whorl papilliform, nearly smooth above, exserted; all nuclear whorls bearing a sharp, well-developed carina, nearer the anterior than the posterior suture, crossed by numerous, very fine, sharply-defined, retractive vertical ribs, 20 appearing on the lower part of the first, 24 entirely crossing the second, 26 on the third, fourth and fifth; postnuclear whorls increasing rapidly in diameter, the last decreasing slightly through the diminishing size of the last anterior spiral cord; transition from the nuclear portion very abrupt, the color becoming a clear, shining white, and the sculpture changing to two well marked spiral cords, the posterior smaller on the first two whorls, larger on the last and nearly equal on all the others; spiral cords continuing to the border of the aperture and bearing throughout prominent, roundish tubercles; axial ribs distinctly, but irregularly, protractive; sutural channels not sinuous, very sharply incised, deep and much narrower than the median channel, truncating the tubercles of the spiral cords; median channels rendered sinuous by the placement of the upper tubercles opposite the interspaces of the lower cord; peripheral keel double, arising at the juncture of the suture with the margin of the aperture, the two parts slowly diverging, nodose, the posterior portion being slightly stronger; basal keels two, nodose, beginning beneath the rather heavy parietal callus; base convex, stained with yellow; aperture circular, outer lip thin; a third meatus or posterior canal opposite the aperture on the last whorl; no sign of a posterior canal at the margin of the aperture; anterior canal long, completely enclosed, opening nearly round, the extremity squarely truncate.

Length, 3 mm.; diameter, 1 mm.

Holotoype: No. 23762, collection of the San Diego Society of Natural History, and sixteen paratypes; collected by Mr. Harris on Ofu, Samoa. Paratypes in the U. S. National Museum and in the collections of Mr. Harris and the authors.

The species is similar to *T. harrisi* Baker and Spicer of this paper in color and general appearance, but the number of nuclear whorls and their sculpturing differ widely, the postnuclear whorls are fewer on the mature shell, and the tubercles of the spiral cords are sharply truncated by the sutures, a characteristic not present in *T. harrisi*. All the specimens taken show the third meatus characteristic of the genus, but it is far less prominent than in *T. harrisi*.

Triphora abbotti Baker and Spicer, new species

Plate 5, fig. 4

Shell sinistral, elongate-conic, rather stout, large for the genus, dove-gray; early nuclear whorls decollated, the one remaining bearing two prominent, shining, obsoletely tuberculate spiral cords separated by a deep, pitted channel nearly equalling the cords in width; postnuclear whorls eleven; transition to postnuclear sculpture rather abrupt, the nearly equal spiral cords quickly losing their indistinct tuberculation and becoming polished and shining, the intercostal channel showing numerous very fine, sinuous, incised spiral lines, deepest in the middle and rising nearly to the edges of the spiral cords; sutures channeled and showing the same sculpture as the intercostal channel, the one above the initial postnuclear whorl nearly equalling the intercostal channel in width; intercostal channel widening much more rapidly on the later whorls; a fine spiral cord beginning on the sixth whorl almost midway between the other two and gradually increasing until nearly, but not quite equalling the other two on the penultimate turn; median cord dividing the median channel into nearly equal parts, each part about equal to the suture in width; last whorl and base showing a fine, transverse wrinkling, becoming close-set, rugose, and nearly equalling the spiral sculpture on the last quarter turn; aperture broadly pear-shaped, showing the external sculpture within; color the same as the exterior but darker beneath the spiral cords; posterior canal a deep, narrow notch; outer lip effuse and abruptly expanding at the margin, wrinkled, thin; parietal wall with a thin callus, free at the outer edge and continuous with the outer lip above; anterior canal long, reflexed, tubular for one-half its length; periphery subangulated by an obscurely tuberculate peripheral keel nearly as large as the anterior cord and slightly nearer to it than the middle cord; base moderately convex, marked by two smaller keels beginning under the parietal callus, the first obsoletely tuberculate and placed wholly on the base, the anterior smaller, smooth, and circling the tubular anterior canal; columella not well marked, showing a distinct callus.

Length, 8.5 mm.; diameter, 2.5 mm.

Holotype: No. 23763, collection of the San Diego Society of Natural History, and fifty paratypes; collected by Mr. Harris on Ofu, Samoa. Paratypes are in the U. S. National Museum and in the collections of Mr. Harris and the authors.

The shell is like a sinistral *Seila*. It somewhat resembles *T. incisa* Pease, as far as can be judged from the inadequate description and poor figure of Tryon, (Man. Conch., IX, 190) and the fuller description of Hedley (Shells of Funafuti), but the coloration is quite distinct, the anterior and posterior postnuclear cords are nearly equal in size and prominence and nowhere show a tendency "to divide into beads." Hedley's specimen evidently represented a smaller species. Of the large number of specimens taken, most of which seem mature, all lack the third meatus and show the posterior canal in its ordinary position within the aperture.

The species is named for Mr. Clinton G. Abbott, Director of the San Diego Society of Natural History.

Triphora granti Baker and Spicer, new species

Plate 5, fig. 5

Shell sinistral, rather large for the genus, elongate-conic, white, profusely flamed with chestnut except on the spiral cords and tubercles; nuclear whorls decollated; postnuclear whorls fourteen, with a superior, sinuous, non-tuberculate spiral cord near the suture, a wide median channel filled with fine, sharply incised spiral striae and numerous minute, slightly protractive incremental lines, about equal to the spiral striae, not crossing the spiral cords, followed by a similar, weaker median cord and a second median channel of the same width, and sculptured the same as the preceding one, followed by a very prominent, strongly tuberculate inferior cord; tubercles large, rather distant, spirally elongate, four or five times as long as broad, polished white on the summits, twelve to fourteen appearing on each whorl; a narrow, sinuous spiral cord between the row of tubercles and the suture, white, articulated with brown, producing a false appearance of tuberculation, and sculptured with fine spiral striae; sculpture and coloration of all the whorls very similar, but becoming less distinct and less distinctly marked on the upper whorls; periphery marked by a narrow channel separating the last spiral cord from a nearly equal, smooth basal keel, followed by a second basal keel bearing small, close-set tubercles; balance of base smooth except for fine, incised spiral striae and incremental lines; suture narrow, sinuous, sharply incised, but not as deep as the peripheral channel; aperture roughly quadrilateral; anterior canal short, moderately retracted, closed for about one-fourth its length; posterior canal a shallow groove within the aperture; parietal callus heavy, with a lobe descending and partially occluding the anterior canal; outer lip thin, translucent, smooth inside, showing the external colors and sculpture within.

Length, 10 mm.; diameter, 3 mm.

Holotype: No. 23764, collection of the San Diego Society of Natural History, and forty-three paratypes; collected by Mr. Harris on Ofu, Samoa. Paratypes in the U. S. National Museum and in the collections of Mr. Harris and the authors.

The shell resembles *T. crenulata* Deshayes, but differs in the extreme size of the tubercles of the anterior cord, while the secondary cords are of much smaller size.

The species is named for Dr. U. S. Grant, IV, professor of Paleontology in the University of California at Los Angeles.

Triphora peleae Baker and Spicer, new species

Plate 5, fig. 6

Shell sinistral, dull white, minute, spindle-shaped, the upper part of the spire slightly concave; nuclear whorls two, the first the larger, rounded and exserted, giving a club-shaped appearance to the nucleus; smaller nuclear whorl spirally carinated, smooth; postnuclear whorls nine, bearing two equal tuberculate spiral cords, about fourteen tubercles appearing on each whorl; the tubercles

slightly elongated spirally and increasing in size on each succeeding whorl; median channel sinuous, wider and shallower than the suture; suture fine, not well-defined, lying at the bottom of a channel separating the two rows of tubercles; base bearing four equal, wavy keels starting from the parietal callus and diverging gradually, the lower two extending on the tube of the anterior canal; parietal callus prominent, semilunar, extending onto the anterior canal; aperture nearly circular, interior white, smooth, outer lip projecting; anterior canal tubular, tapering, projecting from the base at an angle of about thirty degrees from the line of the axis of the shell; third meatus round, enclosed, immediately adjacent to the posterior angle of the aperture.

Length, 5.5 mm.; diameter, 1.75 mm.

Holotype: No. 23765, collection of the San Diego Society of Natural History, and four paratypes; collected by Mr. Harris on Ofu, Samoa. Paratypes in the U. S. National Museum and in the collections of Mr. Harris and the authors.

The species seems to be new and distinct from all the Triphoras of the region. It is named for Miss Pele Spicer who was born in Samoa.

Triphora cookeana Baker and Spicer, new species

Plate 5, fig. 7

Shell sinistral, minute, elongate-conic; nuclear whorls four, smooth, shining, dingy-white, the first papilliform, the others moderately convex, increasing in size very gradually, with well-defined sutures marked vertically by regular, fine, incised lines, about thirty appearing between the third and fourth whorl; postnuclear whorls eight and a half, very slightly convex, ashen-brown, increasing in diameter rather more rapidly than the nuclear whorls to about the sixth, the remaining whorls being about equal; postnuclear sculpture consisting of nearly vertical ribs, about 12 appearing on the first turn; 14 on the second, 16 on the third, 20 on the fourth and fifth and 22 on the remaining turns, crossed by three spiral cords, the middle slightly nearer the posterior than the anterior and slightly stronger on the first five turns, all becoming nearly equal on the remaining whorls; intersections of the ribs and cords marked by nearly round tubercles, sloping a bit more abruptly posteriorly than anteriorly; sutures well-defined but not channeled; periphery marked by a rather strong keel commencing at the upper curve of the outer lip, definitely tuberculate for about a third of a turn, then becoming narrow, sharp and distinctly wavy, the waves correlated with the tubercles of the vertical cords, this keel continuing in all the sutures and defining the sutures anteriorly; base showing no continuation of the vertical ribs but marked by a single wavy, spiral keel separating from the peripheral keel above the aperture and diverging widely to a termination on the columella; aperture rounded, anterior canal open, straight, very short; posterior canal a broad notch within the aperture, not well-defined; outer lip fractured, thin, showing the external sculpture within; columella darker than any other portion of the shell, short, stout, obliquely truncated anteriorly.

Length, 3.5 mm.; diameter, 1 mm.

Holotype: No. 23766, collection of the San Diego Society of Natural History, a unique specimen; collected by Capt. Geo. D. Porter in the Gulf of California, Mexico.

The shell is very distinct from all other species from this Coast, but falls into the very small class of *T. callipyrga* Bartsch in that the three spiral cords are continuous on all the postnuclear whorls. The species is named for Miss Jeannette M. Cooke.

Triphora stephensi Baker and Spicer, new species

Plate 5, figs. 8-9

Shell sinistral, of medium size, stout, spindle-shaped; nuclear whorls decollated; postnuclear whorls seven and a half, scarcely convex, tuberculate at the intersections of the vertical ribs and spiral cords; the first and second bearing two nearly equal tuberculate spiral cords, quite close together but separating on the third turn; a faint median cord beginning on the fourth turn, increasing very gradually and equalling the other two on the last whorl; first whorl having about 14 axial ribs, the second 16, the third 17, the fourth 18 and the last three about 20; peripheral keel about two-thirds the width of the others, sinuous and scarcely tuberculate; sutures moderately channeled and showing an extension of the peripheral cord about six turns; axial ribs slightly, but irregularly protractive, the upper ribs on each whorl ending opposite the interspaces of the succeeding whorl, producing a sinuous suture; base rather evenly rounded, carrying two fairly developed, sinuous keels, beginning close together beneath the parietal callus, but spreading until about equally separated from each other and from the peripheral keel; spiral cords of the first four whorls pale ashen-brown, the posterior slightly lighter, the intervening channels and sutures darker; median cord of the same color as the sutures, becoming pale ashen-brown on the last turn; axial ribs weaker and more widely spaced than the spiral cords, producing a slight spiral elongation of the enclosed pits; parietal callus well-developed, extending on the columella; aperture irregularly subquadrangular; anterior canal short, open, very moderately twisted; posterior canal a broad notch within the aperture; columella rather stout, obliquely truncate below.

Length, 4 mm.; diameter, 1.75 mm.

Holotype: No. 23767, collection of the San Diego Society of Natural History, and a less mature paratype, also in the same collection; collected by Capt. Porter in the Gulf of California, Mexico. Three worn specimens in the collections of the authors are probably of this species.

The paratype retains all but a fraction of the nucleus consisting of nearly three nuclear whorls which can be described as follows: Nuclear whorls nearly three, changing very gradually to postnuclear sculpture, the first slightly fractured above, consisting of a very convex, light yellow spiral cord, separated from a similar cord on the second nuclear whorl by a broad, dark brown, flat-bottomed suture, cord and suture being everywhere marked by very minute tubercles; second nuclear whorl similar to the first in color but beginning to show the start of postnuclear sculpture; remaining nuclear whorl similar in color but with

rather distinct axial ribs, while the nuclear spiral cord becomes tubercular and gradually merges into the anterior spiral cord of the first postnuclear whorl.

The species somewhat resembles *T. oweni* Fred Baker, but the color is different, the shell is stouter, with smaller tubercles, and the broken lines of the axial riblets, with earlier incidence of the median spiral cord, constitute a very marked distinction.

The species is named for Mr. Frank Stephens, Curator Emeritus, San Diego Society of Natural History.

PLATE 5

Fig. 1. *Triphora harrisi* Baker and Spicer, sp. nov. Holotype. Alt. 5.5 mm.

Fig. 2. Same, lateral view, showing aperture and both canals.

Fig. 3. *Triphora ofuensis* Baker and Spicer, sp. nov. Holotype. Alt. 3 mm.

Fig. 4. *Triphora abbotti* Baker and Spicer, sp. nov. Holotype. Alt. 8.5 mm.

Fig. 5. *Triphora granti* Baker and Spicer, sp. nov. Holotype. Alt. 10 mm.

Fig. 6. *Triphora peleae* Baker and Spicer, sp. nov. Holotype. Alt. 5.5 mm.

Fig. 7. *Triphora cookeana* Baker and Spicer, sp. nov. Holotype. Alt 3.5 mm.

Fig. 8. *Triphora stephensi* Baker and Spicer, sp. nov. Holotype. Alt. 4 mm.

Fig. 9. *Triphora stephensi* Baker and Spicer, sp. nov. Paratype, immature specimen showing nucleus.

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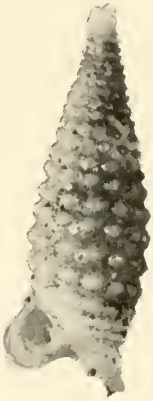
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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME VIII, No. 8, pp. 47-58, plate 6

NEW TRILOBITE SPECIES FROM THE ANTHRACOLITHIC OF NORTHERN CALIFORNIA

AND

GRIFFITHIDES CONWAYENSIS, A NEW NAME FOR A TRILOBITE SPECIES FROM THE ATOKA FORMATION OF ARKANSAS

BY

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Stanford University, California

SAN DIEGO, CALIFORNIA

PRINTED FOR THE SOCIETY

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NEW TRILOBITE SPECIES FROM THE ANTHRACOLITHIC OF NORTHERN CALIFORNIA[1]

BY

HARRY E. WHEELER

Stanford University, California

The first recorded trilobites from the late Paleozoic of California were collected in 1892 by H. W. Fairbanks[2] from the Baird formation near the U. S. Government Fish Hatchery on the McCloud River. His two fragmentary specimens were referred by A. W. Vogdes[3] to *Proetus ellipticus* Meek and Worthen, a species from the Kinderhook group of Illinois.

Unfortunately, Fairbanks' specimens are no longer available for study. Nevertheless, several pygidia collected by J. P. Smith[4] the following year, and referred by him to the same species, are still in the Stanford collection. These, together with a specimen which Professor Muller and I collected in 1931, form the basis for the present description of the Baird species.

The Nosoni formation (Permian) has yielded the other trilobite species described in the following paper.

Genus PROETUS Steininger, 1830

Genotype: *Proetus cuvieri* Steininger, 1830

Proetus bairdensis Wheeler, new species

Plate 6, figs. 1-3

1892. *?Proetus ellipticus* Meek and Worthen, Vogdes, A. W., "Proceedings

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[1] Read before the Paleontological Society of America, Pacific Coast Branch, Berkeley meeting, April 14, 1934.

[2] Fairbanks, H. W., "Geology and Mineralogy of Shasta County," 11th Rep. Calif. State Mineral., p. 39, 1893.

"Notes on some Localities of Mesozoic and Paleozoic in Shasta County, California," Amer. Geol., vol. 14, no. 1, p. 29, 1894.

[3] Zoe, vol. 3, p. 274, 1892. Under the heading of "Proceedings of the Societies, California Academy of Science, Oct. 17, 1892," appears the following quotation: "The secretary read an announcement of the discovery by H. W. Fairbanks of *Proetus ellipticus* Meek, a trilobite from the Waverly Group, in Shasta County, California, identified by Captain A. W. Vogdes."

[4] Smith, J. P., "The Metamorphic Series of Shasta County, California," Jour. Geol., vol. 2, no. 6, p. 595, 1894.

of the Societies, California Academy of Science [meeting], Oct. 17, 1892," Zoe, vol. 3, p. 274.

1894. *?Proetus ellipticus* Meek and Worthen, Fairbanks, H. W., "Notes on some Localities of Mesozoic and Paleozic in Shasta County, California," Amer. Geol., vol. 14, no. 1, p. 29.

1894. *Proetus ellipticus* Meek and Worthen, Smith, J. P., "The Metamorphic Series of Shasta County, California," Jour. Geol., vol. 2, no. 6, p. 595.

Not *Proetus ellipticus* Meek and Worthen, Geol. Surv. Illinois, vol. 3, p. 460, pl. 14, fig. 3, 1868.

Description.—The specimens of this species now available for study are imperfectly preserved fragments of pygidia, an external mold of one individual showing the pygidium, thorax and part of the glabella, and a free cheek (probably of the same individual).

Although the anterior border of the cephalon is unknown, the remaining outline suggests the general form of an elongate ellipse.

The cephalon is straight at the sides, the genal angles being drawn out into slender spines which extend backward to about the fifth thoracic segment. The lateral borders (and probably the anterior as well) are folded upward to form a raised border which is separated from the cheeks by a deep furrow. The occipital ring is about twice as wide as a thoracic segment, and is raised above the level of the highest part of the glabella. These two structures are separated by a distinct groove which extends laterally across the cheeks to the marginal furrow, which it intersects perpendicularly. The posterior-lateral lobes of the glabella stand in low relief, and are bordered anteriorly by shallow lateral furrows which extend obliquely backward to intersect the neck furrow.

The thorax is about one-third wider than long, and consists of nine segments. The moderately arched axis is about equal in width to the lateral lobes, from which it is separated by well-defined dorsal furrows. The lateral lobes are depressed below the axis, are somewhat flattened near the dorsal groove, bend downward at the fulcral point, and are flattened again from there to the margin. Each of the pleurae is marked by a median groove inside the fulcral point.

The pygidium is sub-semicircular, is nearly twice as wide as long, and is of moderately high convexity. It bears about thirteen axial, and eight or nine pleural segments. The axial lobe is prominent, its anterior width being a little greater than that of the lateral lobes. The top of the axis is flattened, and the sides slope steeply to the furrows. The pygidium is entirely surrounded by a smooth marginal border of approximately the same width at all points.

Comparisons and affinities.—This species is in many respects similar to *Proetus ellipticus* Meek and Worthen from the Kinderhook of Illinois, to which it was referred by both Vogdes and Smith. However the Baird species possesses a greater number of segments in the thorax and in both the axial and pleural lobes of the pygidium. Furthermore, both the pygidial axis and the entire pygidium are relatively wider in *Proetus bairdensis* than in the Kinderhook species.

Holotype.—Stanford Univ. Paleo. Type Coll., catalogue no. 777-a.

Paratype.—Stanford Univ. Paleo. Type Coll., catalogue no. 777-b.

Plastotype.—San Diego Society of Natural History Trilobite Coll., catalogue no. 272.

Type locality.—L. S. J. U. loc. 1041, Redding Quadrangle, Shasta County, California. Highly indurated buff colored shale on crest of spur in the S. W. ¼ of the S. E. ¼, sec. 14, T. 34 N., R. 4 W. Elevation 1000 feet.

Formation and age.—Baird formation. The age of the strata at this locality has not as yet been precisely determined. I have shown elsewhere[5] that the *Gigantella*-bearing strata of the Baird formation (which apparently lie stratigraphically below the beds at the *Proetus bairdensis* locality) are of latest Dinantian age. On the basis of stratigraphic position, therefore, it is probable that the strata at the type locality of *P. bairdensis* belong to the Lower Moscovian stage.

Collectors.—S. W. Muller and H. E. Wheeler, 1931.

Genus GRIFFITHIDES Portlock, 1843

Genotype: *Griffithides longiceps* Portlock, 1843

Griffithides nosoniensis Wheeler, new species

Plate 6, figs. 6 and 7

Description.—Although the posterior portion of the pygidium is unknown, the outline of the remainder of the specimen suggests an elongate ellipse as the general form. The greatest width is probably about eight-thirteenths of the length. Measured along the axis, the length of the cephalon is nearly equal to the length of the thorax.

The outline of the cephalon (including the spines) forms slightly more than half of an ellipse. The spines extend backward to about the sixth thoracic segment. The glabella, which is of low convexity, is pyriform, and is especially expanded anteriorly. It is marked by two pairs of obsolete lateral furrows which extend inward from the forward portion of the broad and deep grooves which lie in front of the basal lobes. The occipital ring, whose width is about one-third greater than that of a thoracic segment, is marked anteriorly by a broad furrow. The surface of the eyes has been removed, and, in consequence, their exact form is unknown.

The thorax consists of nine segments. The axis, which is moderately arched, is slightly wider than the lateral lobes, and is separated from them by deep dorsal furrows. The pleurae are also moderately arched, their crests being at the fulcral points, where they bend rather abruptly downward and slightly backward.

The pygidium, which is known only in part, is of fairly low convexity, bears

[5] Wheeler, H. E., "The Carboniferous-Permian Dilemma," Jour. Geol., vol. 42, no. 1, p. 68, 1934.

a greater number of axial than lateral segments (as judged from the forward portion), and possesses, at least anteriorly, a narrow and smooth border.

Comparisons and affinities.—Among the known trilobites, *Griffithides nosoniensis* most closely resembles *G. acanthiceps* Woodward from the Carboniferous limestone of England. The Nosoni species differs from *G. acanthiceps* in the greater anterior expansion of its glabella, its proportionally shorter cephalon, its wider and more anteriorly arched occipital ring, and its obsolete lateral grooves on the glabella.

Holotype.—Stanford Univ. Paleo. Type Coll., catalogue no. 778.

Plastotype.—San Diego Society of Natural History Trilobite Coll., catalogue no. 272.

Type locality.—L. S. J. U. loc. 1034, Redding Quadrangle, Shasta County, California. Dark shale on the south side of the ridge south of Potter Creek, about 250 feet stratigraphically above the McCloud-Nosoni contact. Elevation 1800 feet. N. E. ¼ of the S. W. ¼, sec. 24, T. 34 N., R. 4 W.

Formation and age.—Nosoni formation, Permian (Kungurian?).

Collectors.—S. W. Muller and H. E. Wheeler, 1931.

GRIFFITHIDES CONWAYENSIS, A NEW NAME FOR A TRILOBITE SPECIES FROM THE ATOKA FORMATION OF ARKANSAS

BY

HARRY E. WHEELER

Stanford University, California

An endeavor to locate comparative material representing the genera *Griffithides* and *Phillipsia* has brought to my attention a specimen from the Stanford University Paleontological Collection, which carries the label, "*Phillipsia* (*Griffithides*) *ornatus* Vogdes, Lower Coal Measures, Conway County, Arkansas. Original Type Specimen." A comparison of this specimen with Vogdes' original description[1] and J. P. Smith's republication of that description reveals that both the description and figure of this species are inadequate. Furthermore, a nomenclatural study shows that the specific name is a homonym, and must accordingly be rejected. Thus, the purpose of this paper is to rename, redescribe and refigure this Anthracolithic trilobite species.

Genus GRIFFITHIDES Portlock, 1843

Genotype: *Griffithides longiceps* Portlock, 1843

Griffithides conwayensis Wheeler, new name

Plate 6, figs. 4 and 5

1895. *Griffithides ornata* Vogdes, "Notes on Paleozoic Crustacea No. 4.—On a New Trilobite from Arkansas Lower Coal Measures," Proc. Cal. Acad. Sci., ser. 2, vol. 4, pp. 589-591, text fig.

1895. *Griffithides ornata* Vogdes, "A Supplement to the Bibliography of Paleozoic Crustacea," Proc. Cal. Acad. Sci., ser. 2, vol. 5, p. 73, (1896).

1897. *Phillipsia* (*Griffithides*) *ornata* (Vogdes), Smith, J. P., "Marine Fossils from the Coal Measures of Arkansas," Proc. Amer. Phil. Soc., vol. 35, no. 152, pp. 61-63, pl. 22, fig. 6.

Not *Phillipsia ornata* Portlock, "Report on the Geology of the County of Londonderry and Parts of Tyrone and Fermanaugh," p. 307, fig. 2, Dublin, 1843.

Not *Phillipsia?* (*Brachymetopus?*) *ornata* Hall, "Illustrations of Devonian Fossils," New York Geol. Surv., pl. 21, fig. 1, 1876.

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[1] See synonymy for citation of references not footnoted.

1898. *Griffithides ornatus* Vogdes, Weller, S., "A Bibliographic Index of North American Carboniferous Invertebrates," U. S. Geol. Surv., Bull. 153, p. 302.

1933. *Griffithides ornatus* Vogdes, Williams, J. S., "A New Pennsylvanian Trilobite from Missouri," Jour. Washington Acad. Sci., vol. 23, no. 9, pp. 431-432.

Description.—The general form is sub-ovate, with the greatest width being about two-thirds that of the length. Measured along the axis, the cephalon, thorax and pygidium are all of about equal length.

The outline of the cephalon (excluding the spines) forms about half of a near circle. The head-shield is bounded by a marginal border which extends backward from the posterior-lateral angles, in the form of genal spines, to at least the fourth or fifth thoracic segment. The cephalic border and spines bear about eight very fine parallel costae. The glabella is pyriform and gibbous in front. Its basal lobes are small, but well marked by deep furrows, whose anterior ends are connected by a shallow groove across the glabella. From the center of this groove, a faint furrow extends backward, thus defining two small rounded nodes near the posterior margin of the glabella. The occipital ring is broad and well defined, its width being nearly twice that of a thoracic segment. The eyes are large, smooth and quarto-spherical.

The thorax consists of nine segments. Its axis is strongly arched, and bears a series of about ten small tubercles across the center of each segment. The posterior border of each pleural segment, beyond the fulcral point, bears a row of extremely fine tubercles.

The pygidium is very convex, and is surrounded by a marginal border which widens anteriorly. Its strongly arched axis consists of eleven segments, each bearing, along its flattened crest, a row of six nodes which are slightly larger than those of the thorax. Segmentation on the sides of the axis is but faintly defined. The lateral lobes of the pygidium consist of seven segments with a vestige of an eighth. These segments are divided by deep furrows, and each bears a node at its fulcral point, from whence it is abruptly truncated.

Comparisons and affinities.—Vogdes compared this trilobite with *Griffithides scitula* Meek and Worthen from the "Illinois Coal Measures." However, as pointed out by Williams,[2] any comparison with *G. scitula* is of little value, since the type is apparently no longer available for study, and since Meek and Worthen were the only authors known to have examined the type.

G. conwayensis compares favorably in many respects to *G. olsoni* Williams[3] from the Cherokee shale (Lower Pennsylvanian) of Missouri. *G. conwayensis* differs from *G. olsoni*, however, in its more conspicuous basal glabellar lobes, its greater number of pleural segments of the pygidium, and in the noded character of its axis.

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[2] Williams, J. S., Jour. Washington Acad. Sci., vol. 23, no. 9, p. 431, 1933.

[3] *Ibid.*, pp. 429-435.

G. conwayensis appears to be more closely allied to *G. parvulus* Girty[4] from the Wewoka formation of Oklahoma. The Arkansas species differs from *G. parvulus* in its much smaller width-length ratio, its narrower neck ring, its less distinctly defined transverse glabellar furrow, the absence of any indication of a second such furrow, and the presence of a longitudinal groove dividing the basal glabellar lobe.

Discussion.—In 1895 Vogdes described and figured this species under the heading "GRIFFITHIDES ORNATA sp. nov." At the time of its proposal, the validity of that name depended entirely upon the taxonomic rank of *Griffithides*, as interpreted from Vogdes' paper. If it be construed that he regarded *Griffithides* as a subgenus of *Phillipsia*, his specific name becomes a homonym of *Phillipsia ornata* Portlock, 1843. In his description, Vogdes makes no mention of the genus *Phillipsia*, from which we may interpret that he treated *Griffithides* as being of full generic rank. On the other hand, under the subheading of *"Affinities and differences,"* he cites alternately *Phillipsia* (*Griffithides*) *scitula* and *Griffithides scitula*, thus, apparently sanctioning the subgeneric usage of *Griffithides*. Furthermore, it should be noted that the name *Griffithides* is masculine, while the specific name *ornata* is feminine. This discordance might be cited as additional evidence for Vogdes' intention to employ *Griffithides* as a subgenus of *Phillipsia* (feminine); otherwise, the name should have been *ornatus*. One might construe, therefore, either that Vogdes did or did not regard *Griffithides* as a subgenus of *Phillipsia*. J. P. Smith, however, in his republication of Vogdes' description, leaves no doubt as to the status of the name in question. Under the heading of "Genus PHILLIPSIA, Portlock," he cites the species as *Phillipsia* (*Griffithides*) *ornata* A. W. Vogdes. Through this action, Vogdes species unquestionably becomes a homonym of *Phillipsia ornata* Portlock; and it must accordingly be rejected and supplanted by a new name. I therefore propose the name *Griffithides conwayensis* for this species.

Holotype.—Stanford Univ. Paleo. Type Coll., catalogue no. 5077. The holotype of *Griffithides conwayensis* is the same specimen upon which Vogdes based his species *"ornata."*

Plastotype.—San Diego Society of Natural History Trilobite Coll., catalogue no. 274.

Type locality.—L. S. J. U. loc. 1040, Morrillton Quadrangle, Conway County, Arkansas. Near the center of the N. W. ¼, sec. 17, T. 5 N., R. 16 W.

Formation and age.—Atoka[5] formation, Lower Moscovian (Lower Pennsylvanian).

Collectors.—Arkansas Geological Survey.

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[4] Girty, G. H., New York Acad. Sci. Annals, vol. 21, p. 154, 1911; Bull. U. S. Geol. Surv., no. 544, pp. 268-270, pl. 18, figs. 14-15, 1915.

[5] Carey Croneis shows ("Geology of the Arkansas Paleozoic Area," Ark. Geol. Surv., Bull. 3, 1930, structural map in fold) that the locality of *Griffithides conwayensis* lies very close to the axis of the Redemption anticline; and on page 265 of the same paper, he states that the surface rocks of that structure belong to the Atoka formation. A personal communication from Dr. Croneis (Feb., 1934) gives reassurance that this locality is underlain by the Atoka formation.

PLATE 6

Fig. 1. *Proetus bairdensis* Wheeler, new species. Rock surface containing the holotype (incomplete external mold of cephalon, thorax and pygidium), and paratype (free cheek). Holotype, Stanford Univ. Paleo. Type Coll., no. 777-a, paratype, no. 777-b. L. S. J. U. loc. 1041, Baird formation, Redding Quadrangle, Shasta County, California. x 1.9.

Fig. 2. *Proetus bairdensis* Wheeler, new species. Paratype; same specimen as in upper left corner of fig. 1. x 1.9.

Fig. 3. *Proetus bairdensis* Wheeler, new species. A clay cast impressed from the external mold (holotype) shown in fig. 1. x 1.9.

Fig. 4. *Griffithides conwayensis* Wheeler, new name. Holotoype, Stanford Univ. Paleo. Type Coll., no. 5077. L. S. J. U. loc. 1040, Atoka formation, Lower Moscovian, Morrillton Quadrangle, Conway County, Arkansas. x 2.1.

Fig. 5. *Griffithides conwayensis* Wheeler, new name. A line drawing traced from a photograph of the specimen shown in fig. 4.

Fig. 6. *Griffithides nosoniensis* Wheeler, new species. Holotype, Stanford Univ. Paleo. Type Coll., no. 778. L. S. J. U. loc. 1034, lower Nosoni formation, Permian, Redding Quadrangle, Shasta County, California. x 2.1. The dark areas on either side of the anterior half of the specimen represent the cavities remaining after the dissolution of the marginal border and genal spines of the cephalon.

Fig. 7. *Griffithides nosoniensis* Wheeler, new species. A line drawing of the cephalon traced from a photograph of the specimen shown in fig. 6. Gl, glabella; L, basal glabellar lobe; OR, occipital ring; S, suture; GS, genal spine.

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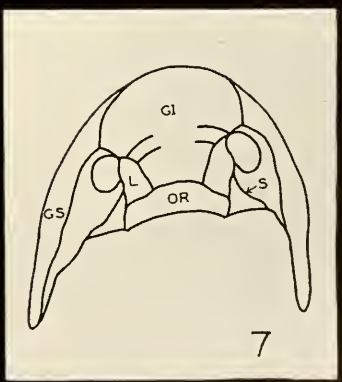

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME VIII, No. 9, pp. 59-66, plate 7

REVISION OF SOME CALIFORNIA SPECIES OF ASTRODAPSIS

BY

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Stanford University, California

SAN DIEGO, CALIFORNIA

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REVISION OF SOME CALIFORNIA SPECIES OF ASTRODAPSIS

BY

GEORGE L. RICHARDS, JR.

Stanford University, California

Extensive field work throughout the central Coast Ranges of California during the past two years has shown that various species of the genus *Astrodapsis* are of value in establishing the stratigraphic correlation of Upper Miocene and Lower Pliocene formations.

During the paleontological study of these late Tertiary marine sediments, the valuable works of Clark and Twitchell,[1] and Kew,[2] were found to be almost indispensable in the determination and identification of the various genera and species of the Pacific Coast Echinoidea. However, a study of the original description and figure of the type of *Astrodapsis antiselli* Conrad suggested that the workers had misidentified this species, which is the type of the genus *Astrodapsis*.

Through correspondence with the Curator, Division of Mollusks, U. S. National Museum, photographs of specimens were obtained which confirmed this opinion, and indicated that the specimen figured by Clark and Twitchell (U. S. National Mus. Cat. No. 165466a) cannot be regarded by Kew as a type specimen of *A. antiselli* Conrad. Furthermore, this specimen is not from the original lot, nor even from the type locality. A photograph of the above mentioned specimen shows it is not a true *Astrodapsis antiselli* as originally defined and figured by Conrad. Unfortunately, Kew followed Clark and Twitchell and recognized this figured specimen as the holotype. The problem is therefore two-fold: (1) biologic identification of species, and (2) nomenclatorial. In order to correct this confusion it is necessary to make several corrections and, in addition, propose one new name, to wit:

Astrodapsis salinasensis, new name

"*Astrodapsis antiselli* Conrad," of Clark and Twitchell, 1915, also of Kew, 1920, but not of Conrad, 1856.

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[1] Clark, W. B. and Twitchell, M. W. The Mesozoic and Cenozoic Echinodermata of the United States. U. S. Geological Survey, Monogr. 54, 1915.

[2] Kew, W. S. W. Cretaceous and Cenozoic Echinoidea of the Pacific Coast of North America. Univ. Cal. Pub. Geol., Vol. 12, no. 2, pp. 23-236, 1920.

Determinative characters.—Clark and Twitchell, verbatim:[3] "Test medium in size; regularly oval in marginal outline, longer than broad, slightly truncated at anterior end, slightly pointed at posterior end, with faint notches opposite ends of petals; margin rounded and very thick, almost as thick as rest of test. The whole form is considerably depressed, almost equally so from edge to edge, and therefore subdiscoidal; the upper surface with broad flattened ambulacral ridges alternating with narrow interambulacral depressions; apex eccentric anteriorly, in front of depressed apical system; lower surface slightly concave. Ambulacral petals large, broad, tumid, especially near apical system; poriferous zones narrow, at first diverging, then converging slightly from one-fourth to one-third the way to margin and again diverging to the wide open ends which are nearly to the margin. Peristome central; the main ambulacral grooves straight, well defined, and rather deep from peristome to margin and continuing as faint lines over margin to near apex, two faint lines are given off about half way to margin, which continue over margin to near apical system. Periproct small, infra marginal, almost marginal."

Dimensions.—Specimen B, type, (U. S. National Mus. Cat. No. 165466a): length, 57 mm.; width, 50 mm.; height, 14 mm.

Localities.—Specimen B (No. 165466a): "2 miles south of San Lucas, Monterey County, Cal." (Clark and Twitchell).

Collection.—U. S. National Mus. Cat. No. 165466, Specimen A, cotype. U. S. National Mus. Cat. No. 165466a, Specimen B. Both the type and the specimens collected by Ralph Arnold, which include specimens A and B.[4]

Remarks.—*Astrodapsis salinasensis* (No. 165466a) misidentified as "*Astrodapsis antiselli* Conrad" by Clark and Twitchell, and by Kew, is herein figured (Plate 7, figs. 2a, 2b, and 2c) for comparison with the original type of true *Astrodapsis antiselli* Conrad (U. S. National Mus. Cat. No. 13337), which is lebelled "Conrad's type," from Estrella, Monterey County, California. (See Plate 7, figs. 1a, and 1b). *A. salinasensis* differs from *A. antiselli* Conrad in the following characters:

Astrodapsis salinasensis	**Astrodapsis antiselli** Conrad
Test: Discoidal, oval; slightly notched.	Pentagonal; markedly notched opposite ends of petals.
Margin: Broadly rounded and thick; almost as thick as rest of test,—"biscuit shaped."	Slightly rounded; greatest elevation adjacent to the depressed apical system.
Apical system: Moderately depressed.	Deeply depressed.
Tubercles: Very prominent.	Not prominent.
Petals: Low, broad, and tumid.	Elevated, narrow, angular.
Interambulacral areas: Rounded, shallow grooves.	Angular, deep grooves.

[3] *Op. cit.* p. 198.

[4] This information from Clark and Twitchell, 1915, p. 199.

Distribution.—Geographically *Astrodapsis salinasensis* occurs abundantly in the fine, medium to coarse, white, littoral marine sandstones at the top of the Santa Margarita formation, or sandstone facies of the Upper Miocene Monterey Shale, throughout the entire Salinas Valley, Monterey County, California, as well as in similar standstones of the Santa Margarita formation as exposed along Bean Creek, Santa Cruz County, California, and the uppermost Santa Margarita sandstones exposed along Saucelito Creek, Nipomo Quadrangle, San Luis Obispo County, California.

Stratigraphically *Astrodapsis salinasensis* occurs in a monoclinal, upper Miocene section, approximately 250 feet above organic and siliceous shales containing a *Nonion schencki* foraminiferal assemblage, which in turn overlies sandstones containing *Astrodapsis tumidus, Astrodapsis whitneyi, Ostrea titan corrugata*, and associated faunal assemblage. It occurs below sandstones containing *Astrodapsis* cf. *jacalitosensis* and lower Pliocene mollusks belonging to the Jacalitos faunal assemblage.

Associated faunal assemblage.—Astrodapsis salinasensis occurs with the following forms: *Pecten estrellanus* Conrad (18-20 rib var.), *Tritonalia* sp., *Balanus concavus* Bronn, *"Tamiosoma" gregaria* Conrad, *Astrodapsis spatiosus* Kew.

Additional revision.—In the monographs by Clark and Twitchell, and Kew, the true *Astrodapsis antiselli* Conrad was named *Astrodapsis arnoldi* through the unfortunate misidentification mentioned above. In order to correct this nomenclatorial problem, it is necessary to consider those forms originally described by Kew (1921) as subspecies of *Astrodapsis antiselli* Conrad, or to regard them as of full specific rank. The revised nomenclature of all the forms involved in this problem is as follows:

Old arrangement (Kew)	*New arrangement*
Astrodapsis arnoldi arnoldi	**Astrodapsis antiselli** Conrad
" " **depressus**	" **depressus**
" " **fresnoensis**	" **fresnoensis**
" " **crassus**	" **crassus**
" " **spatiosus**	" **spatiosus**
" " **peltoides**	" **peltoides**
"Astrodapsis antiselli Conrad" of Kew, not Conrad	**Astrodapsis salinasenis,** new name

Acknowledgments.—The writer is indebted to Dr. Alexander Wetmore, Assistant Secretary of the Smithsonian Institution, and Mr. Wm. B. Marshall of the Division of Mollusks, U. S. National Museum, for permission to reproduce photographs of the type of *Astrodapsis antiselli* Conrad (U. S. National Mus. Cat. No. 13337); photographs of *Astrodapsis salinasensis* new name (U. S. National Mus. Cat. No. 165466a) were supplied through the courtesy of the U. S. Geological Survey. He is also grateful to Dr. Hubert G. Schenck of Stanford University, and Dr. U. S. Grant of University of California at Los Angeles, for suggestions concerning nomenclatorial problems and the preparation of the manuscript.

PLATE 7

All figures approximately natural size.

Fig. 1a. *Astrodapsis antiselli* Conrad.
Genotype, U. S. National Mus. Cat. No. 13337. Upper surface of test. Estrella, Monterey Co., California.

Fig. 1b. *Astrodapsis antiselli* Conrad.
Same specimen. Lateral view of test.

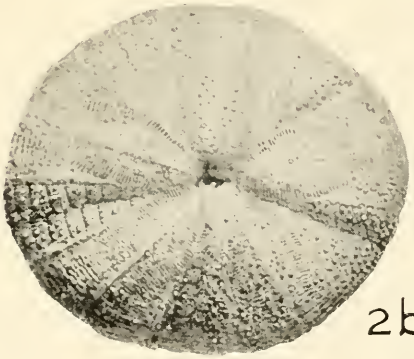
Fig. 2a. *Astrodapsis salinasensis*, new name.
Holotype, U. S. National Mus. Cat. No. 165466a, Specimen B. Lower side of test. Two miles South of San Lucas, Monterey Co., California.

Fig. 2b. *Astrodapsis salinasensis*, new name.
Same specimen. Upper surface of test.

Fig. 2c. *Astrodapsis salinasensis*, new name.
Same specimen. Lateral view of test.

2 a.

1a.



2b.

2c.

1b.

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. VIII, No. 10, pp. 67-68 AUGUST 24, 1935

THE MANGROVE WARBLER OF NORTHWESTERN MEXICO

BY

A. J. VAN ROSSEM
San Diego Society of Natural History

In the spring of 1930 while at Tobari Bay on the coast of southern Sonora I collected a series of breeding mangrove warblers. These, on a more critical examination than I was able previously to give them, prove not to be of the subspecies *castaneiceps,* but to belong to an undescribed race which is apparently more closely related to *Dendroica erithachorides xanthotera* of the Pacific coast of Central America. At present the combined material in the San Diego Society of Natural History and the Dickey collection (for the privilege of using which I am under obligations to Mrs. Dickey) totals 64 specimens. These consist of 15 *xanthotera,* 30 *castaneiceps,* and 19 of the Sonora race. A description of the new race, together with comment on the others is herewith offered. The new race may be called

Dendroica erithachorides rhizophorae subsp. nov.

Type.—Male adult, no. 17090, collection of the San Diego Society of Natural history; Tobari Bay, Sonora, Mexico, April 30, 1930; collected by A. J. van Rossem.

Subspecific characters.—General size very similar to *Dendroica erithachorides xanthotera* Todd of the Pacific coast of Central America, though averaging even smaller in wing length and size of bill; definitely smaller in all dimensions than *Dendroica erithachorides castaneiceps* Ridgway of southern Lower California. The tail has less yellow than in *xanthotera;* more than in *castaneiceps.*

Adult males have the chestnut of the throat more restricted and the under parts usually more heavily streaked than in either *xanthotera* or *castaneiceps;* coloration of both sexes otherwise similar to *castaneiceps*, that is to say less richly colored than *xanthotera.*

Range.—Coast of southern Sonora from the northern limit of mangroves at Tepopa Bay south (Kino Bay; Guaymas; Tobari Bay) to Agiabampo on the Sonora-Sinaloa boundary, and probably for some distance further south.

Remarks.—In considering the most characteristic features of the three races under comparison there are immediately noticeable the large size of *castaneiceps*, the restriction of chestnut and heavy streaking of *rhizophorae*, and the rich general coloration of *xanthotera.*

There are two very distinct color phases in the young of this species, and these persist at least through the post-juvenal moult. Whether or not they normally persist beyond that stage I do not know. There is evidence both ways in the combined series of 64 skins. However, both the gray and the yellowish olive green phases are present in unquestionably young females of *castaneiceps* and in spring females of uncertain age of *rhizophorae.* In *xanthotera* the pale phase is almost indistinguishable from the olive green phase of the northern races and the bright phase is, of course, infinitely richer and yellower. Evidence that the pale phase persists at times into the adult stages is shown by two fully adult males of *xanthotera* from Costa Rica.

It is certain that a large amount of carefully collected specimens will be necessary in order to determine not only the duration of the pale phase, but its relative abundance in different geographic areas. The material before me indicates that it is *much* more prevalent southerly.

Measurements of Adult Males in Millimeters

Extremes and Averages

	Wing	*Tail*	*Exposed Culmen*	*Tarsus*	*Middle Toe minus Claw*
6 *xanthotera*	64-68	47-51	10.5-12.0	18.7-19.3	11.2-12.3
	(65.8)	(49.3)	(11.1)	(19.5)	(11.5)
7 *rhizophorae*	61-65	47-52	9.6-10.7	19.7-21.0	11.3-11.9
	(63.2)	(49.4)	(10.3)	(20.0)	(11.7)
17 *castaneiceps*	65.69	53-57	10.8-12.0	20.3-22.2	11.5-13.1
	(67.1)	(53.8)	(11.3)	(21.3)	(12.4)

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. VIII, No. 11, pp. 69-72 AUGUST 24, 1935

A NEW RACE OF BROWN TOWHEE FROM THE INYO REGION OF CALIFORNIA

BY

A. J. VAN ROSSEM

San Diego Society of Natural History

In the latter part of May of the present year I was invited by Mr. Christopher Henne of Pasadena to accompany him on a short trip to the Argus Mountains, a small, excessively arid range in southern Inyo and extreme northern San Bernardino Counties. This range forms, in part, the western rim of Panamint valley. The region is adequately mapped by the U. S. Geological Survey and is covered by the Searles Lake and Ballarat Quadrangles, and Plate X of Water Supply Paper No. 490.

Our three day reconnaissance of Mountain Springs Canyon on the west slope of the range in Inyo County was made more than casually interesting by the discovery that the thickets of willows, which in interrupted fashion follow the canyon bed from 4200 to 5500 feet altitude, harbored a breeding colony of brown towhees. This colony is of course effectually isolated from the geographically nearest race of brown towhee, *Pipilo fuscus carolae,* by the Sierra Nevada as well as by intervening deserts.

The six specimens collected cannot satisfactorily be placed with any of the known races of this rather "plastic" species, a not surprising circumstance in view of the fact that the isolated habitat lies in a region far removed faunally from the coastal and interior valley habitats of other brown towhees of the *crissalis* group. This region, a part of the Inyo Division of the Great Basin Faunal Area, is already characterized by numerous subspecies of birds and mammals. The new towhee is named as

Pipilo fuscus eremophilus subsp. nov.

Type.—Breeding male adult, no. 17083, collection of the San Diego Society of Natural History; Lang Spring, 5500 feet altitude, Mountain Springs Canyon, Argus Mountains, Inyo County, California, May 22, 1935; collected by A. J. van Rossem.

Subspecific characters.—Most closely resembles *Pipilo fuscus carolae* McGregor of the Sacramento-San Joaquin Valley of California, but bill smaller, tarsi and toes decidedly shorter, and coloration slightly darker and grayer. Resembles *Pipilo fuscus crissalis* of the Pacific slope of southern California, but wing and tail longer, bill much more slender, both in lateral and vertical profile, and coloration grayer.

Range.—Argus Mountains of Inyo and San Bernardino Counties, southeastern California.

Remarks.—The gray, dark coloration of the desert race is more pronounced in the single juvenile than in the worn adults. Since wear tends to obscure comparative color values between races of this species it seems likely that fresh-plumaged adult specimens will show even more definite differences than are apparent in worn series.

There are several matters of interest connected with the characters displayed by this desert race of brown towhee. First, there is no approach in any particular toward *mesoleucus,* indeed the tendencies are *away* from that race. Second, there would appear to be every reason to suspect, *a priori,* that a race resident in the Argus range would show relative pallor, compared with other *crissalis* subspecies, for not only is the region one of extreme aridity and high temperatures, but the soil color is definitely pale—a light colored granite which weathers reddish rather than gray. Large size and pallid coloration rather generally characterize Inyo subspecies, but the trend in this instance is an exception.

In going over the published literature I was surprised to find that Frank Stephens had taken a brown towhee in the Argus Mountains on April 25, 1891, at which time he was a member of the Death Valley Expedition. The record seems to have been generally overlooked by reviewers, though Ridgway (in Pt. 1 of Birds of No. & Mid. Amer., p. 435), in the bibliography of "*Pipilo crissalis senicula,*" repeats the record which was first published by Fisher on page 105 of North American Fauna No. 7.

Through the courtesy of the Bureau of Biological Survey I am able to examine this specimen. It has become reddened by post-mortem color change and is now indistinguishable in color from recently collected examples of *carolae.* However, the mensural characters accord strictly with those of *eremophilus.* The precise locality on the label is given as "Searles Garden," presumably at, or near, Searles Borax Works at the south end of the range.

In addition to this specimen borrowed from the Biological Survey, I must acknowledge the use of specimens in the Dickey collection, and the courtesy of Dr. Joseph Grinnell in sending me a comprehensive series of *carolae* from the west slope of the Sierra Nevada.

MEASUREMENTS OF MALES IN MILLIMETERS[1]

Extremes and Averages

	Wing	*Tail*	*Exposed Culmen*	*Depth at Base*	*Tarsus*	*Middle Toe minus Claw*
10 *crissalis* from Los Angeles and Ventura Cos.	90-97 **(92)**	97-105 **(100)**	14.0-15.2 **(14.4)**	8.8-10.4 **(9.6)**	26.0-28.5 **(26.8)**	17.8-19.0 **(18.4)**
10 *carolae* from the range	95-100 **(96)**	103-117 **(108)**	15.7-16.8 **(16.2)**	9.7-10.6 **(10.2)**	27.8-30.0 **(28.4)**	19.5-21.0 **(20.1)**
4 *eremophilus*	94-95 **(95)**	103-108 **(106)**	14.5-14.7 **(14.6)**	8.8-9.4 **(9.0)**	25.5-27.5 **(26.6)**	17.5-19.5 **(18.4)**

[1] Wing and tail measurements are all from worn specimens, so far as possible in comparable stages of abrasion. Fresh plumaged birds measure somewhat longer. In this connection, as well as for modern systematic treatment of various California races, see the measurements recorded by Swarth, Condor, 1918, pp. 117-121, and Grinnell and Swarth, Univ. Calif. Pub. Zool., 21, no. 18, 1926, pp. 427-433.

28,898

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. VIII, No. 12, pp. 73-74 AUGUST 24, 1935

A NEW SILKY POCKET MOUSE FROM SONORA, MEXICO

BY

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Curator of Birds and Mammals, San Diego Society of Natural History

In a collection of mammals secured in early 1935 by the writer for the San Diego Society of Natural History at Bahia Kino, Sonora, Mexico, are four specimens of *Perognathus longimembris* that differ in several characters from the hitherto described forms of this species. This race may be known as:

Perognathus longimembris kinoensis subsp. nov.
KINO SILKY POCKET MOUSE

Type.—From Bahia Kino, Sonora, Mexico (more precisely—from the northern end of the sand dune peninsula that borders the bay and forms the northern arm of the estuary); no. 11300, collection of the San Diego Society of Natural History; adult male; collected by Laurence M. Huey, February 26, 1935.

Characters.—In color, *kinoensis* is darker than *Perognathus longimembris bombycinus*, its nearest relative. The most prominent characters of this form are cranial, and compared with *bombycinus* the skull of *kinoensis* is more rounded and narrower across the bullae. The interparietal is almost square in shape, and the nasals are longer and more attenuated. In some respects it approaches *P. l. pacificus* from the coastal region of San Diego County, California; for example, in its very small size and compressed, arched skull with rounded bullae. However, in color these two races are widely different.

Measurements.—*Type*: Total length, 135; tail, 80; hind foot, 17; ear, 4. *Skull* (*type*): Greatest length, 20.7; width across bullae, 11.4; interorbital constriction, 4.6; nasals, 7.2; tooth row, 2.6.

Range.—So far as known, only the type locality.

Remarks.—*P. l. kinoensis* provides an interesting illustration of color development, as compared with the other two races of *Perognathus longimembris* mentioned in this paper. It is a well established fact that desert and coastal forms are respectively light and dark. This is true of *P. l. bombycinus* and *P. l. pacificus*. In *P. l. kinoensis*, however, we have a coastal race whose range borders the humid tropical desert of central Sonora. Here it has developed a grayish cast, as contrasted with the rich black tendencies found along the coast in southern California.

Specimens examined.—*Perognathus longimembris bombycinus*: 2 from 6 miles east of Yuma, Arizona (type locality); 2 from 3 miles west of Pilot Knob, Imperial County, California; 3 from San Felipe, Lower California, Mexico. *Perognathus longimembris pacificus*: 60 from Tia Juana Valley, San Diego County, California (type locality); 6 from 4 miles north of Oceanside, San Diego County, California; 1 from San Onofre, San Diego County, California. *Perognathus longimembris kinoensis*: 4 from Bahia Kino, Sonora, Mexico (type locality).

28,878

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME VIII, No. 13, pp. 75-90, plate 8, map

A NEW SUBSPECIES OF CROTALUS CONFLUENTUS, THE PRAIRIE RATTLESNAKE

BY

LAURENCE M. KLAUBER

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SAN DIEGO, CALIFORNIA

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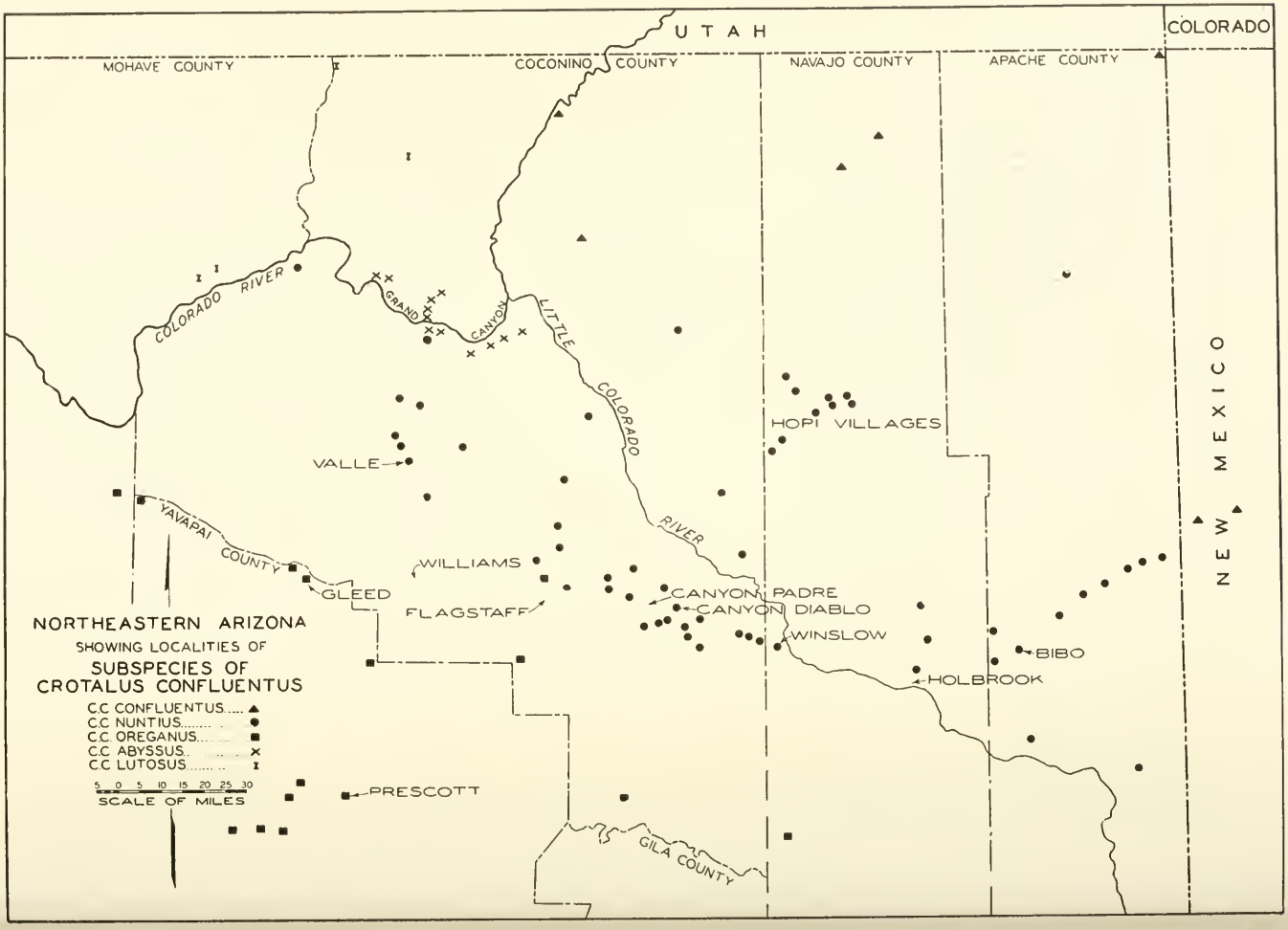
UTAH
COLORADO
MOHAVE COUNTY
COCONINO COUNTY
NAVAJO COUNTY
APACHE COUNTY
NEW MEXICO
COLORADO RIVER
GRAND CANYON
LITTLE COLORADO RIVER
HOPI VILLAGES
VALLE
YAVAPAI COUNTY
WILLIAMS
GLEED
FLAGSTAFF
CANYON PADRE
CANYON DIABLO
WINSLOW
BIBO
HOLBROOK
PRESCOTT
GILA COUNTY
NORTHEASTERN ARIZONA
SHOWING LOCALITIES OF
SUBSPECIES OF
CROTALUS CONFLUENTUS
C.C CONFLUENTUS....
C.C NUNTIUS.....
C.C OREGANUS.....
C.C ABYSSUS.....
C.C LUTOSUS.....
5 0 5 10 15 20 25 30
SCALE OF MILES

A NEW SUBSPECIES OF CROTALUS CONFLUENTUS, THE PRAIRIE RATTLESNAKE

BY

LAURENCE M. KLAUBER

Curator of Reptiles and Amphibians, San Diego Society of Natural History

It is with some hesitation that the writer proposes the differentiation of the Prairie Rattlesnake of the Little Colorado Basin and the surrounding territory in Arizona as a new subspecies of *Crotalus confluentus*. The latter is a wide-spread and rather variable snake; it has already been divided into five territorial races, e. g., *confluentus, abyssus, concolor, lutosus,* and *oreganus*. However, surveying the type subspecies *confluentus confluentus,* as now recognized, we find that the Arizona specimens differ from those inhabiting the rest of the range from Canada to Mexico in consistent and conspicuous characters.

I do not favor the indiscriminate splitting of reptile species in each instance where significant differences in some character can be found to exist between two or more geographical groups. Thus, specimens of *Crotalus confluentus oreganus* from Washington can be quite readily distinguished from southern California specimens by color and pattern; and it can be shown mathematically that Texas specimens of *Crotalus atrox* have a significant difference in such important characters as dorsal scale rows, ventrals, and labials from Arizona individuals. But, after all, these differences are largely technical; the snakes themselves are essentially the same, and it will serve no practical purpose to recognize each of such differences, with the multiplicity of subspecies that would result in plastic forms.

But the prairie rattlesnakes of Arizona, and particularly those found in the drainage area of the Little Colorado River, between Canyon Padre on the west and Bibo on the east, are so conspicuously different in size and color, and so significantly different in scale counts from the snakes found beyond the Continental Divide, that the divergence will appeal to the nonherpetologist as well as to the specialist. Venom data will be clarified by the recognition of this form, owing to the differences from the typical subspecies in yield, and possibly in quality as well. Thus it would seem that it is desirable to make this segregation.

It is true that there is some lack of uniformity in the specimens found in this area, so that the relationship pattern is not as clear as might be desired. Much of this may be attributed to a few inaccurate locality records, or to such effect as the religious rites of the Indians may have had upon distribution; but in any case, even if we consider all of the Arizona specimens (rather than only the stunted specimens from the Winslow area), we will still find a significant divergence, when comparisons are made with the type subspecies.

While the differences herein mentioned were first recognized in 1927, initially leading to some confusion with *C. tigris,* a discussion of the problem has been postponed until adequate material has become available. Studies have now been made of 200 Arizona specimens of this form, and scale counts of 1900 specimens of *confluentus confluentus* from other states are at hand for purposes of comparison.

Crotalus confluentus nuntius[1] subsp. nov.

Arizona Prairie Rattlesnake

Type.—No. 3105 in the collection of L. M. K. Collected at Canyon Diablo, Coconino County, Arizona, by R. L. Borden, August 9, 1930.

Diagnosis.—A stunted subspecies of *Crotalus confluentus*, predominantly reddish-brown in coloration and with low dorsal and ventral scale counts.

Description of Type.—Adult male. Length (live measurements) 468 mm. to rattles, tail length 38 mm., ratio 0.081. Length of head 24 mm., times contained in body length 19.5. Width of head 17 mm. Width across the supraoculars 11 mm., distance between supraoculars 4.5 mm., ratio 2.44.

The head is subtriangular, depressed, and, except for the supraoculars, covered with small scales. These are raised and unkeeled, excepting those in the temporal area and toward the neck.

The dorsal scale rows are 23-23-19; the first row dropped is the 6th, the second the 5th. At mid-body all scale rows are keeled, excepting the first two on either side. The central dorsal rows are smaller than the lateral; they are the more strongly keeled and have moderate posterior bosses. The ventrals number 166, and the caudals 26, in a single series. The anal is entire. The supralabials number 16-16; the infralabials 15-14. The rostral is higher than wide; eight scales contact it posteriorly, a first supralabial and prenasal on each side, and 4 internasals. Between the internasals and the supraoculars there are two canthals on each side. The scales on the top of the head, anterior to the supraoculars, number 18. The anterior intersupraoculars are 4+6; the anterior boundary of these scales is

[1] *Nuntius,* the messenger. In the Hopi Snake Ceremonial, these snakes are used as messengers to the gods of the underworld.

indefinite. The nasals are 2-2, the anterior larger; there are 0-1 loreals. The upper preocular contacts the prenasal on the left; on the right the contact is prevented by the juxtaposition of loreal and posterior canthal. There are two preoculars on either side, the upper larger, the lower crescent-shaped and bordering the pit above. The postoculars are 3-3, the total scales in the orbit, 8-9; scales from the labials to the orbit, 2+3, 2+4. The first and eighth supralabials are the largest. The small scales anterior to the pit number 4-3.

The first infralabials are undivided and are in contact on the median line; there are no intergenials. The mental is subtriangular, contacting only the first infralabials and a small submental. The genials are in a single pair, short and obtuse, and contact 4-5 infralabials.

The head above is light red-brown, irregularly spotted with darker. The supraoculars are crossed with light marks, widening inwardly. On the side of the head there is a light preocular stripe passing backward to the angle of the mouth, and a second narrower postocular light stripe, about $1\frac{1}{2}$ scales wide, the upper edge of which is rather indefinite. Between the two light stripes there is a dark ocular stripe about $2\frac{1}{2}$ scales wide ending above the commissure. The infralabials are punctated.

The ground color of the body is light reddish-brown, upon which there are superimposed 43 blotches of darker red-brown. On the sides there are secondary and tertiary series of ill-defined spots; posteriorly these are confluent with the dorsal series so that the last ten blotches become transverse rings, of a somewhat lighter color than the anterior blotches. The dorsal blotches are irregular both in shape and outline; at mid-body they are ellipses with the major axes transverse to the snake. They are about 11 scale rows wide, and longitudinally are 2 to 3 scales (end to end) long. The blotches are wider (along the body of the snake) than the interspaces. The blotches internally are somewhat darker at the borders than centrally; exteriorly there is a white edge, but this is neither regular nor always present. The blotch borders are independent of scale edges, which is typical of *confluentus* as opposed to *scutulatus*. The tail is crossed with 10 rings, all being brown except the last two, which are black, thus being in strong contrast with the rest of the body. The ventrals are straw colored, and somewhat punctated, particularly adjacent to the dorsals.

The rattles, of which 3 remain, measure about 7.3 mm. across. Studies of the rattles of this form indicate that there were not less than ten rattles in the complete string. The base of the rattles is black.

The hemipenis is completely bifurcate with divided sulcus. The base on the outer shoulders is covered with short, heavy spines, there being about 24 major spines on each shoulder, and some 55 smaller points. There are no spines in the crotch. The branches are covered with laminate fringes, there being about 27 on each lobe. The boundary between spines and fringes is sharply defined. The ratio between lobe length and diameter is 2.1, which is approximately the proportion usually found in *confluentus confluentus*.

General Description and Remarks.—The following is a summary of scale counts and measurements of 108 specimens from the area between Canyon Padre,

Coconino County, Arizona, on the west and Bibo, Apache County, Arizona, on the east, and will serve to indicate character variations in specimens from that area wherein this form adheres most closely to the type. Other Arizona specimens are subsequently discussed, but in this summary of the new subspecies it is deemed advisable to omit specimens which might be considered intergrades with other subspecies.

Size, small. Scale rows at midbody usually 23 (48 per cent) or 25 (50 per cent); rarely 21, 22, or 27 (less than 1 per cent of each). The scales are keeled, except the first two on the sides. Posterior scale bosses are not conspicuous. Ventrals: males, max. 181, min. 166, av. 172.29±0.26, interquartile range 170.1—174.5 (68 specimens); females, max. 182, min. 169, av. 177.51±0.32, interquartile range 175.5—179.5 (39 specimens). Anal entire. Caudals: males, 21 to 28, average of 68 specimens 24.8; females, 14 to 21, average of 39 specimens 18.5. These extremes are seldom attained; the males usually have from 23 to 26 and the females from 17 to 20. The caudals, while generally entire, may have a few at either end of the series divided.

The supralabials average 14.8; they usually number 15 (43 per cent), or 14 (30 per cent); occasionally 16 (18 per cent) or 13 (6 per cent); rarely 17 (less than 3 per cent). The infralabials average 15.3; they generally number 15 (38 per cent), 16 (35 per cent); occasionally 14 (18 per cent) or 17 (7 per cent); rarely 12 or 13 (less than 1 per cent of each).

The rostral is higher than wide, and in contact with the prenasals. The prenasals are always in contact with the supralabials. The internasals (scales in contact with the rostral between nasals, regardless of size or relative position) usually number 3, 4, or 5; rarely 2 or 6, the average being exactly 4. The scales on the crown, anterior to the supraoculars, vary from 12 to 31; the average is 20.2, with an interquartile range of 17.6 to 22.7. The minimum scale rows between supraoculars are usually 3 or 4, rarely 2 or 5, averaging 3.52. Supraocular sutures or indentations are not present.

The nasals are 2-2. About 90 per cent of the specimens have one loreal, the rest two or none; the upper is always the smaller when present. The scales along the *canthus rostralis* from internasals to supraoculars usually number two, rarely 1 or 3; the posterior is the largest of the series.

The upper preocular, which is the larger, is usually not in contact with the postnasal. In 82 per cent such contact is prevented by the contact of the post-canthal with the loreal, in 5 per cent by the presence of a small upper loreal.

The upper preocular is usually undivided; only in one instance is an upper corner cut off at the eye. The lower preocular is crescent shaped and constitutes the upper border of the pit. The small scales anterior to the pit usually number 3 to 5; they are not carried forward to the rostral.

The scale rows from labials to orbit usually number 2+3 or 2+2. Generally the 5th and 6th supralabials are the largest; however they do not conspicuously exceed the others in size. Usually the third and fourth are in contact with the lower pit border.

The first infralabials are usually undivided (only 5 per cent divided). Normally 4 are in contact with the genials on each side.

The mental is subtriangular. The genials are in a single pair, relatively short and obtuse, intergenials being present in 13 per cent. Also 13 per cent of the specimens have submentals.

The equation for the head length of *nuntius* approximates $H=0.0318L+7.7$, where the head and body length are given in millimeters. Thus a 500 mm. snake would have a head length of about 23.6 mm. L/H is, of course, not a constant, but closely approximates 21.2 in adults. The ratio of the distance across the supraoculars to the space between averages 2.64 (range 2.25 to 3.13) in 86 specimens.

The ratio of the length of tail to total length, exclusive of rattle, varies from about 0.065 to 0.089 in the males (average 0.077), and 0.045 to 0.074 in the females (average 0.056).

The largest preserved specimen examined measured 732 mm. (29 in.). The average size at birth is probably 165 mm. ($6\frac{1}{2}$ in.). Specimens exceeding 650 mm. (26 in.) are not common. The smallest gravid female measured 395 mm. ($15\frac{1}{2}$ in.).

In color the typical specimens from the Little Colorado Basin are pink, red-brown, brown, or gray-brown. Pinks predominate about Adamana and Holbrook; west of Dennison dark-brown is the typical color. Those from the vicinity of Moqui have an orange tinge. An occasional olive-brown specimen may be found in the vicinity of Winslow. Dark gray-brown specimens are found at Meteor Crater. The reddish hues tend to fade in preservative so that preserved specimens show less of this color than live material.

The head is rather brightly marked. Supraocular light cross-dashes are always in evidence in well preserved material; usually these are inwardly divergent. The postocular light line is $1\frac{1}{2}$ to 2 scales wide, thus being intermediate between typical *confluentus* and *oreganus*. The infralabials are punctated, otherwise the underside of the head is immaculate.

The body blotches number from 35 to 52, interquartile range 39.8 to 44.6, mean 42.2 ± 0.23. The blotches are of the *confluentus confluentus* type, that is, the edges do not follow scale outlines. Longitudinally, they are wider than the interspaces. In shape they are highly irregular but are usually cross-ovals, rectangles, or figure-eights. The internal edges are darker than the blotch centers and are sometimes black; the external edges are lighter than the ground color and are sometimes almost white. Secondary and tertiary blotches, while usually present, are ill-defined. Caudad the blotches become transverse rings and are lighter than the anterior blotches.

The ventral surfaces are straw-colored. Usually the ends of the ventral scales are punctated, but they may be immaculate.

The tail rings vary from 5 to 12 (usually 8 to 11) in the males (average 9.4), and 5 to 10 (usually 6 to 8) in the females (average 7.3). The anterior rings are not in strong contrast to the ground color and are often ill-defined. The posterior rings (1 to 3) are black, in strong color contrast with the rest of the body, but are so poorly outlined as not to be conspicuous. The rattle matrix is black.

The rattles are small and delicate. The average widths of the first seven rattles in mm./10 are 43-50-60-69-73-80-82.

The hemipenis is completely bifurcate with divided sulcus. There are about 67 short spines on the shoulders; some are quite small so that the counting is not always accurate. There are no spines in the crotch. The lobes are covered with fringes which are laminate in front and reticulate in back, as is usual in *confluentus*. The fringes vary from 20 to 31; most specimens have from 25 to 29, the average being 27. This is distinctly lower than the *confluentus* average. The ratio of the lobe length to diameter is 2.2. The border between spines and fringes is sharply defined.

The venom yield is about 38 mg. of dry purified venom per fresh adult snake. The fang length, measured from upper lumen to tip, of a 500 mm. snake (head length 23.6 mm.) will closely approximate 4.1 mm.

Range.—Specimens of the typical stunted *nuntius* have been collected at the following points located along the line of the Santa Fe Railway or adjacent to U. S. Highway 66 between Canyon Padre, Coconino County, Arizona, on the west and Bibo, Apache County, Arizona, on the east:

Coconino County:

Canyon Padre (at U. S. 66)
Babbitt Tank
7 mi. and 6 mi. W. of Two Guns (on U. S. 66)
5 mi. E. of Canyon Padre (on U. S. 66)
Canyon Diablo (Type locality; station on Santa Fe Railway)
Two Guns
4 mi. NW. of Meteor Crater
Sunshine
Dennison
Moqui
6 mi. W. of Winslow

Navajo County:

Winslow
3, 6, and 22 mi. N. of Holbrook (Road to Keams Canyon)

Apache County:

Adamana
6 mi. N. of Adamana
Bibo

This territory is an arid prairie about 4800 to 5200 feet in altitude; it is cut by deep arroyos, of which Canyon Diablo is the most conspicuous, and buttes are scattered about.

Discussion.—Having described and summarized the new subspecies, *nuntius*, two interrelated problems remain: First, the disposition of the specimens from those areas of Arizona outside the Canyon Padre-Bibo section, hitherto considered *confluentus confluentus;* and secondly, the relationship of the new form with the other *confluentus* subspecies.

Nuntius is clearly a stunted offshoot of *confluentus confluentus;* this is shown by the pattern on both head and body. The characteristic arrangement of

the head marks, the nature of the blotch edges, the number and form of the tail rings, all show a close affinity to the parent form. The difference between the two is found in the reduction in scale counts so often seen in stunted races. This may be exemplified by comparing the dorsal scale rows and ventral scales of the two forms. For our basic *confluentus confluentus* data we may use 875 specimens from Colorado, in which State the type specimen was collected. We have the following:

SCALE ROWS—PER CENT DISTRIBUTION[2]

	29	27	25	23	21
Confluentus (Colo.)	3	67	30		
Nuntius		1	50	48	1

The averages of the ventral scale counts are as follows:

AVERAGE VENTRAL SCALES

	Males	*Females*
Confluentus (Colo.)	178.84±0.10	185.73±0.11
Nuntius	172.29±0.26	177.51±0.32

In addition there are differences in color and size, although it is admitted that these characters are of less importance than scale counts, since they are more plastic. *Confluentus*, from its type area, is usually green or olive-green, while *nuntius* is pink or red-brown. A large adult male *confluentus* from Colorado will have a length of about 1000 mm.; in other parts of the range the size may exceed 1200 mm.; *nuntius* seldom exceeds 650 mm. The smallest Colorado female with eggs (out of 149 gravid females) was 588 mm. long; the smallest *nuntius* (out of only 6 gravid specimens) was 395 mm. Thus, without doubt, there is a real difference in adult size in these forms, a fact further validated by rattle studies.

Cope's *pulverulentus*[3] does not anticipate *nuntius;* the type of the former is a large snake with 27 scale rows, although the ventral scale count is low for typical *confluentus*. The punctations and the number of intersupraoculars, which led Cope to describe this as a new subspecies, are found not to differ either in the type of *pulverulentus*, or in other specimens collected in the same area in New Mexico, from specimens of *confluentus* taken near its type locality in Colorado.

From *lutosus* we find *nuntius* to differ in size, pattern, color, number of ventrals, and number of scales on the snout before the supraoculars; and the same is true to a less extent in comparing *abyssus* and *nuntius*. Just as *nuntius* is a stunted form of *confluentus confluentus*, so *concolor* seems to be a stunted form of *lutosus; concolor* is superficially more like *nuntius* than is any other of the *confluentus* subspecies, although it is doubted whether the relationship is a direct one. In any case, they differ in color, pattern, and head scales, especially the number of scales before and between the supraoculars.

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[2] Even rows are distributed equally to the next odd number above and below.

[3] Proc. Acad. Nat. Sci. Phila., 1883, p. 11.

Nuntius differs from Arizona *oreganus* in color, pattern, and head scales.

These differences are discussed somewhat more in detail in considering the other specimens hitherto classified as *confluentus confluentus* from the area in northeastern Arizona surrounding the territory in which *nuntius* reaches its most typical development. Of these there are available 82 specimens from the following localities:

COCONINO COUNTY:

*Lee's Ferry Bridge, South Side
*Base of Echo Cliffs, near Cedar Ridge Trading Post
Havasupai Point, South Rim, Grand Canyon
El Tovar, Grand Canyon
15 mi. S. of El Tovar
Red Butte
22 mi. N. of Williams (El Tovar Road)
Anita
Willaha
5 mi. N. of Valle
Valle
36 mi. N. of Maine Sta.
12 mi. N. of Deadman's Flat
Deadman's Flat
Medicine Valley, NE. of San Francisco Mt.
Near San Francisco Mt.
Tanner Tank
15 and 20 mi. NE. of Flagstaff (Tolchaco Road)
7 mi. NE. of Leupp
12 mi. E. of Mouth of Moencopie Wash
East Foot Monument Point
6 mi. E. of Flagstaff
1 mi. N. of Winona
Angell

NAVAJO COUNTY:

*Kayenta
*Marsh Pass
Shimopovi
8, 10 mi. S. of Oraibi (Road to Leupp)

APACHE COUNTY:

*Four Corners
10 mi. NE. of Chin Lee
Navajo
Chambers
Cheto
8 mi. E. of Sanders
Houck
5 mi. W. of Lupton
40 mi. S. of Navajo
10 mi. NE. of St. Johns

* Of these localities, all should be considered to be within the range of *nuntius* except those marked*; those so marked are to be considered *confluentus confluentus*. (See map).

In addition the species has been observed at the Hopi villages of Hotevila, Oraibi, Shipaulovi, Mishongnovi, Toreva, Sichomovi, and Walpi.

The following specimens of *confluentus confluentus* or *nuntius* are contained in the U. S. National Museum: No. 5271 from Fort Buchanan, No. 8395 from Fort Apache, and No. 11879 from Fort Whipple. These three localities are in *oreganus* territory from which, in the last 25 years, no specimens of *confluentus* have been forthcoming. In the days when these snakes were collected it was the custom to label specimens with the name of the military post from which they were forwarded to the Smithsonian Institution. Sometimes the actual point of collection was some hundreds of miles away. It is therefore deemed advisable to omit consideration of these three specimens as being of uncertain locality.

Summarizing the situation it may be said that we have sufficient material, upon which to draw conclusions, from areas to the east and west of the Canyon Padre-Bibo area, but not from the north.

East of Bibo we have undoubted intergradation between *nuntius* and *confluentus confluentus*. As we pass through Navajo, Chambers, and Houck there is a gradual increase in body size, and a shift in color from pink through red-brown and olive-brown toward green. Twenty-five dorsal scale rows becomes the mode and there is a moderate increase in the dorsal scale count. At Gallup, New Mexico, larger, olive-green specimens with 25 scale rows predominate; these are to be considered *confluentus confluentus*, although the ventral scale counts are lower than in the typical form from Colorado.

This easterly intergradation is broad and gradual, for the habitat conditions change slowly; a sharp line of demarcation is not to be expected since true intergrades occur over a wide territory. Merely for purposes of allocation we may consider that the Arizona-New Mexico line (at U. S. 66) is the approximate location of the boundary between the forms; thus the Arizona specimens are assembled with *nuntius* rather than *confluentus confluentus*.

West of Canyon Padre the situation is not so simple. First, we have, at such points as Angell and Winona, small snakes only slightly larger than those from Winslow, but distinctly darker and more brightly marked. While the majority are dark-brown or red-brown, a few are olive-brown. The same situation exists at Deadman's Flat in the area northeast of the San Francisco Peaks. All of these snakes have low scale counts; they are clearly *nuntius*, differing only in color, and with a slight increase in size, from the typical specimens.

Proceeding further west we come to the Coconino Plateau, lying south of the Grand Canyon. A good series of specimens is available from Anita, Valle, and a few other scattered points round about. Here the snakes are superficially much more like *confluentus*. They are decidedly larger than typical *nuntius*. Browns predominate, with large dorsal blotches close together and without light edges; olive-greens and greens are likewise present. They are much punctated. Yet with all these *confluentus* tendencies, they are far from typical *confluentus*, for the dorsal and ventral scale counts are as low or lower than in *nuntius*. Thus, in these all-important characters they more nearly resemble the latter and will be so classified.

A few specimens are available from the south rim of the Grand Canyon; these show decided *abyssus* tendencies, particularly in high number of intersupraoculars and scales on the snout. Even the specimens from as far south as Anita show this tendency to a slight degree. Thus, I consider these snakes to be *nuntius,* intergradation with *abyssus* occurring at the south rim of the Canyon.

Also, in this Coconino Plateau area, we have the *nuntius-oreganus* relationship to determine, and this is the most difficult of all. A number of *oreganus* are available from the vicinity of Gleed; these show undoubted resemblances to the Valle *nuntius;* two of them might almost be considered intergrades. The Valle specimens present some interesting tendencies as compared with the main group of *nuntius,* particularly in color and pattern, toward these Gleed *oreganus.* Unfortunately, no specimens have been taken between Valle and Gleed. Although the intervening territory is suitable to either subspecies, I do not affirm that intergradation occurs, for there are some differences in head scales which rather sharply divide the two. For instance, almost all the Gleed specimens have the prenasals separated from the supraoculars, which is not the case with the Valle specimens.

Another uncertainty is the following: There are some areas, particularly in the vicinity of the San Francisco Mountains, where *nuntius* and *oreganus* have been taken so near to each other that an actual overlap is indicated. If this be the case they could hardly be expected to intergrade in the Valle-Gleed territory. Only the receipt of additional material can resolve this doubt.

It may be of interest ot note that the actual and direct intergradation of *oreganus* and *confluentus confluentus,* although possible in central Idaho or west-central New Mexico has not yet been demonstrated. It may occur through *lutosus* in southern Idaho; the *lutosus-oreganus* intergradation is demonstrated near the Oregon border, but the *confluentus-lutosus* merger is not. Thus, the most certain intergradation (as known today) of the two terminal forms, *oreganus* and *confluentus,* is that via the detour *confluentus, nuntius, abyssus, lutosus, oreganus,* and this is not as certain as is desirable.

Lastly there arises the question as to the classification of the prairie rattlers found to the north of the Little Colorado Basin. Of these unfortunately we have insufficient specimens to determine their position definitely. The situation is further complicated by the fact that the Hopi Indians use these rattlesnakes in their Snake Dance and sometimes have brought in specimens from distant points. On one occasion when I saw the dance there was a mixture of "large greens" and typical *nuntius.* In scale counts the snakes of this north area are more like *confluentus confluentus* than those from the vicinity of Gallup or the Coconino Plateau, this being especially true of the specimens from beyond the Hopi Reservation to the north. Thus, tentatively, I am disposed to consider the snakes of the extreme northeastern corner of Arizona (i. e., the San Juan drainage area) as *confluentus confluentus* rather than *nuntius.* This would also seem to prevent direct intergradation between *nuntius* and *concolor.* A definite decision on this relationship cannot be made until more specimens are available from the San Juan basin, and especially along the San Juan River, from which two or three peculiar specimens have been seen.

Conclusion.—*Crotalus confluentus nuntius* is described as a new subspecies. It is a stunted form reaching its most typical development in the Winslow-Holbrook area in Arizona. Eastward it intergrades with *C. c. confluentus* and westward, at the south rim of the Grand Canyon, with *abyssus*. It may intergrade with *oreganus* southwest of the Coconino Plateau. The snakes of the San Juan basin in Arizona are of uncertain status, but are probably *C. c. confluentus*.

PLATE 8

Fig. 1. Comparison of adult *Crotalus confluentus nuntius* (left) with adult *C. c. confluentus* (right). The former is from near Winslow, Arizona; the latter from Kansas.

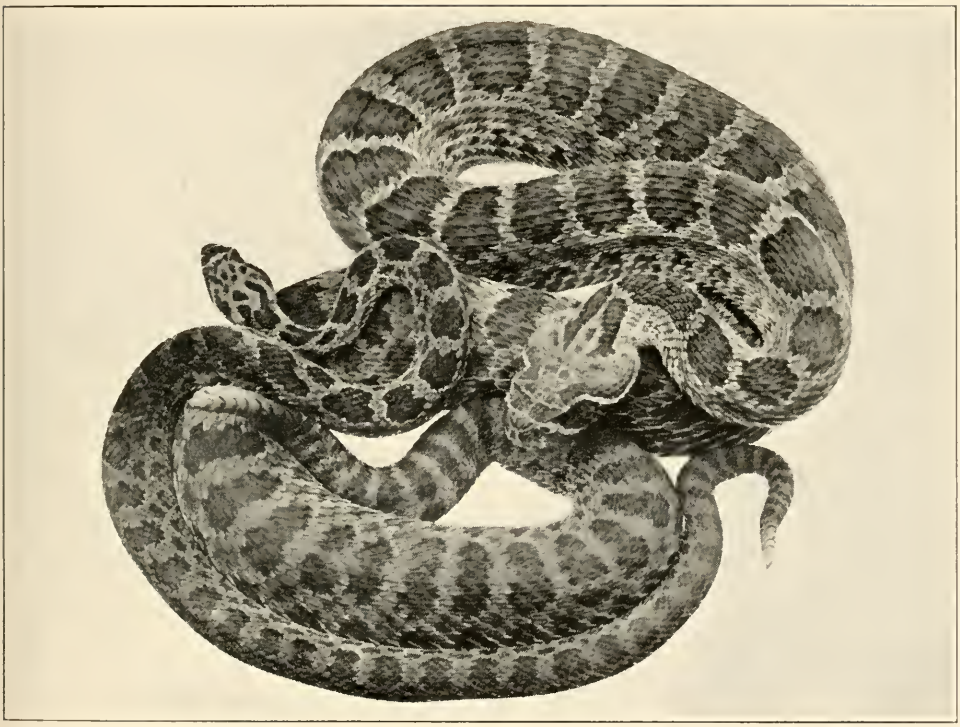

Fig. 1

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TRANSACTIONS

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NEW OR LITTLE KNOWN CRABS FROM THE PACIFIC COAST OF NORTHERN MEXICO

BY

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NEW OR LITTLE KNOWN CRABS FROM THE PACIFIC COAST OF NORTHERN MEXICO

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The marine decapod crustacean fauna of the Gulf of California and neighboring Pacific waters has such a rich and varied number of species that it is not to be wondered at that so many new forms have been found there from time to time. Geographic isolation and lack of roads or facilities for observation has kept this territory a *terra incognita,* except for the sporadic efforts of collectors on a few expeditions whose chief interest did not lie primarily in the crustacean field. It is not possible for a single expedition into these waters to make more than a reconnaissance of the littoral zones. Extreme low tides do not occur with sufficient frequency during daylight hours to allow an intensive study of many and varied localities in any one season. So it is not surprising that diligent effort is rewarded by prodigal returns. The following described new species bear testimony to this.

During the several times I have collected there I have found a number of obscure species in the Gulf of California of which some lacked descriptions of the opposite sex, and some were of forms the type specimen of which had been destroyed. I have thought it best to include a description of at least one already named species in this paper, in order to replace the lost type by a new one which could be kept in a safe repository for the benefit of future workers in this field.

I am greatly indebted to Dr. Mary J. Rathbun and Dr. Waldo L. Schmitt, of the U. S. National Museum, for their unfailing cooperation, to Dr. Edith Berkeley, of the Pacific Biological Station, at Nanaimo, British Columbia, for her prompt determination of the worm host of the new *Polyonyx,* and to Mr. Anker Petersen, of Beverly Hills, California, who has made and donated, for the benefit of science and the embellishment of these pages, the splendid drawings which accompany the text. For their accuracy and fidelity I can vouch.

PORCELLANIDAE

Polyonyx quadriungulatus, n. sp.

Plate 9

Type.—Female, holotype; Cat. No. 750, San Diego Society of Natural

History; male, paratype; Cat. No. 751, S. D. S. N. H.; one paratype, Cat. No. 71336, U. S. National Museum: from Estero de la Punta Banda, south of Ensenada, Baja California, Mexico; January 3, 1935; collected by Steve A. Glassell, Beverly Hills, California, in whose collection the remaining paratypes are located.

Diagnosis.—Carapace $\frac{1}{3}$ broader than long. Hands unequal. Carpus of chelipeds $\frac{2}{3}$ as wide as long. Dactyli of ambulatory legs armed with four unguicles on the inner edge.

Description.—Carapace about $\frac{1}{3}$ broader than long, appears smooth and shining, but has a fine transparent pubescence growing in a series of transverse lines, convex fore and aft, transversely ovate, regions indistinct; two subcrescentic pits in center of carapace, at base of gastric region; front truncate, straight, entire, in dorsal view. Antero-lateral margin divided into two arcs by a broad sinus above the base of the first antennal joint. Posterior margin concave. Chelipeds unequal, dissimilar, microscopically punctate; merus stout, short, produced into a prominent semi-oval lamina distally and anteriorly; carpus stout, about $\frac{2}{3}$ as wide as long, with a deep concavity on the under side for the reception of the posterior side of the manus; manus, small at juncture with carpus, increasing in breadth and thickness to the central part of the hand, which here forms an obtuse angle, the distal portion pointing outward; dense, long pubescence fringes the outer lower margin of manus; pollex of major hand turning outward, upward at tip, armed with a row of low blunt teeth, largest and highest in the center; the prehensile finger is curved outward, tip downward, and meshes on the outside of the tip of the pollex; it is armed with a cutting edge of small teeth extending from the tip to a large tooth in the middle; from this point to the gape, on a different axis, are five blunt, low teeth, the last a lobe; the minor hand has a straight finger and pollex, curved at the tips; the tip of the dactylus meshes on the inside of the pollex, the pollex being the longer; a double row of small sharp teeth on both members, the outside row entire, the inner row extending half way from the tip. Ambulatory legs longest in the order 1-2-3; merus wide, crested on 1-2, flattened on 3, a row of sharp outward pointing spines on posterior margin of merus of legs 2-3; propodi compressed, posterior margin armed with four forward pointing spines, a transverse pair at distal end, followed by a single spine set a little back of these, also a spine near center and on the same axis as the last; dactyli with four unguicles, numbers 1-2-3 curving inward, the 4th outward; upper margin of carpus and both margins of propodi and dactyli fringed with hair. The telson is composed of seven plates.

Sexual variation.—Males smaller than females, also darker in color.

Color in life.—Ground color of carapace a dark brown, mottled with green and red, chelipeds the same, while the legs are lighter and banded. Abdomen mottled and opalescent.

Measurements.—Female holotype: length of carapace 9.1 mm., width 13.5 mm. Male paratype: length 7.9 mm., width 10 mm. Largest female (imperfect): length 10.2 mm., width 15.5 mm.

Range.—Known only from type locality.

Material examined.—A series of 8 females and 5 males.

Habitat.—This species is found commensal with the chaetopodous annelid, *Chetopterus variopedatus* (Renier), which was found in a leathery double-ended tube, located at mean low water level, on an eel grass mud flat. Only the larger tubes were found to have crabs in them. These tubes are about a yard long by an inch in diameter.

Remarks.—Related to *P. nitidus* Lockington, 1878, but differs in the following respects: hands unequal, instead of equal; carpus of chela $\frac{2}{3}$ as wide as long, instead of $\frac{1}{2}$ as wide; dactyli of ambulatory legs with four unguicles, instead of with various numbers of unguicles. I am unfamiliar with any other species of this genus and it seems remarkable to me that the dactyls of the chelipeds are not symmetrically disposed, the dactyl of the major hand overlapping on the outside of the pollex, while the reverse is true of the dactyl of the minor hand.

LEUCOSIDAE

Speloephorus schmitti, n. sp.

Plate 10

Type.—Female, holotype; Cat. No. 67728, U. S. National Museum: from San Felipe, Baja California, Mexico, low tide; May 10, 1933; collected by E. H. Quayle. One paratype male, one paratype female, Cat. No's. 752 and 753, S. D. S. N. H.; collected by S. A. Glassell, same locality, June 12, 1933; five female paratypes in the collection of Steve A. Glassell, Beverly Hills, California.

Diagnosis.—Carapace subtriangular, one and a half times as broad as long. Hinder edge of carapace sharp, straight.

Description.—Carapace subtriangular, approximately one and a half times as broad as long; surface granulate, formed by a pavement of flat and rounded, close-set granules. Subhepatic region prominent in dorsal view, postero-lateral margin a broad arch which terminates posteriorly in a slight tooth at the beginning of the posterior hollow. Two small excrescences on the anterior branchial margin, a short transverse raised line above. Hepatic region high, frontal teeth deeply separated, a median groove on the cardiac region. Intestinal region thick, forming a large protuberance within the posterior cavity, not visible in dorsal view; the border of the cavity roughly pentagonal. Hinder edge of carapace sharp, straight, invisible from above. Merus of chelipeds trilobed on outer margin; carpus short; hands dilated at proximal end, a straight crest on upper margin; fingers thin, flat, curved, grooved, fitting close together. Ambulatory legs short, merus lobed, carpus and propodus cristate, dactyli spinous. Enitire ventral side including legs and chelipeds tuberculate.

Sexual and juvenile variations.—Abdomen of female heavily eroded. Male abdomen tuberculate, with a backward pointing spine at the proximal end of penult segment. Juvenile carapace with a high tuberculate median crest, a transverse row of four granulated lobes, two branchial, two epibranchial, a deep transverse sulcus posterior to these lobes. In the very small specimens the posterior border is visible in a dorsal view.

Color in life.—Carapace a salmon pink, blotched with white, ventral side and legs a muddy white.

Measurements.—Female holotype: length of carapace 27 mm., width 36.8 mm. Male paratype: length 27.4 mm., width 36.5 mm.

Range.—Upper end of Gulf of California, Mexico.

Material examined.—Angeles Bay, Baja California, January 4, 1932, by S. A. Glassell: two females and one male, juveniles. San Felipe, Baja California, May and June, 1933, by E. H. Quayle and S. A. Glassell: two females (one the holotype), and one male. San Felipe, Baja California, May 28, 1934, by S. A. Glassell: two females.

Habitat.—Found at low tide, under dense sea lettuce and weeds among rocks.

Remarks.—This species is dedicated to Dr. Waldo L. Schmitt, of the U. S. National Museum, to whom I am indebted for assistance and counsel.

GONEPLACIDAE

Panoplax mundata, n. sp.

Plate 11

Type.—Male, holotype; Cat. No. 754, San Diego Society of Natural History; female, paratype; Cat. No. 755, S. D. S. N. H.; one paratype, Cat. No. 71337, U. S. National Museum: from San Felipe, Baja California, Mexico, near upper end of Gulf of California; June 2, 1934; collected by Steve A. Glassell, Beverly Hills, California, in whose collection the remaining paratypes are located.

Diagnosis.—Carapace convex anteriorly and posteriorly. Front bilobed, truncate, straight. Sixth segment of male abdomen broader than base of seventh. Antero-lateral borders converging slightly posteriorly.

Description.—Carapace slightly depressed at cardiac region, convex anteriorly and posteriorly; transversely flat at fourth marginal tooth; regions fairly well marked, surface finely punctate, granulate on outer regions. Front truncate, divided into two straight margined lobes by a sharp V shaped median notch. Width of orbit and frontal lobe subequal. Five lateral teeth including the orbital tooth; the second shallow, separated from the first by a shallow sinus; the third large, blunt, right-angled, pointing forward and slightly upward; the fourth sharper, right-angled, with anterior margin short and nearly transverse to the carapace; the fifth small, not projecting beyond the general outline. Postero-lateral margins moderately converging behind. Hinder edge of carapace straight. Merus stout, dentate on upper margin. Carpus oblong, with a blunt tooth at inner angle, granulate on upper surface; a slight anterior transverse groove. Hands unequal, smooth and rounded; a row of hairs on upper crest of hand and finger; a lateral groove from near tip of pollex, paralleling lower outer margin; prehensile teeth broad, low, a large one at base of dactylus on major hand; no gape; a dark brown patch of color on pollex, extending slightly on palm of male; fingers brown, curved at tips. Ambulatory legs long, hairy on margins, merus slightly compressed; dactyli long, lanceolate, hairy to tip.

Sexual variation.—Slight. Color on pollex of female not continued on palm.

Color in life.—Ground color of carapace pinkish cream, overlaid with a few reddish orange spots, irregularly broadcast. Chelipeds, merus and carpus same color as carapace; fingers a deep dark brown, tips white. Ambulatory legs a yellowish cream, with a few reddish-orange spots; tips of dactylus amber. Ventral side same as dorsal, but without spots.

Measurements.—Male holotype: length of carapace 4.6 mm., width 6 mm. Female paratype, length 4.9 mm., width 6.5 mm.

Range.—Known only from the type locality.

Material examined.—A series of over fifty specimens of both sexes, many juvenile.

Habitat.—This species inhabits a soft mud bottom, covered by five to seven fathoms of muddy water.

Remarks.—The fifth tooth of the carapace is hard to distinguish in any but the largest specimens, and even then the pubescence will have to be removed to show as in the plate. This species is the Pacific analogue of *Panoplax depressa* Stimpson, 1871, but differs from the species in the squarer carapace, straighter front, smaller size, and lack of distinct epigastric lobes.

PINNOTHERIDAE

Pinnotheres clavapedatus, n. sp.

Plates 12, 13

Type.—Female, holotype; Cat. No. 756, San Diego Society of Natural History: from San Felipe, Baja California, Mexico, low tide; June 1, 1934; collected by Steve A. Glassell. One paratype, male, Cat. No. 757, S. D. S. N. H.; one female and one male, paratypes, Cat. No's. 71338 and 71333, U. S. National Museum; three males, sixty females, paratypes, in the collection of Steve A. Glassell, Beverly Hills, California.

Diagnosis.—First ambulatory leg stout, propodus greatly dilated at distal end, clavate, second leg similar but not so stout, third and fourth legs slender. Dactylus of outer maxilliped narrow-spatulate, slightly curved, attached near middle of propodus and reaching $\frac{1}{4}$ its length past the extremity of the latter.

Description of female.—Carapace smooth, shining, semi-hard, convex in both directions, eyes not visible in dorsal view; regions not defined; posterior margin concave. Merus of outer maxillipeds widest at distal $\frac{3}{4}$, narrowing at distal end; propodus longer than carpus; dactylus narrow-spatulate, slightly curved, attached near middle of propodus and reaching $\frac{1}{4}$ its length past the latter member. Hands cylindrical, similar, increasing in width to base of prehensile finger, smooth with exception of a row of forward-pointing hairs on inner side of pollex, extending back to a point under the gape; inner tip of dactylus hairy. First and second legs stout, smooth, with propodi cylindrical and distended at distal ends; first leg much the larger, dactylus short, stout, straight on under side, arched on upper, with needle tip; second dactylus longer and heavier; third and fourth legs

very slender; dactylus of third leg long, slender, slightly curved; dactylus of fourth leg arched on the anterior margin, larger at proximal third than at base, a row of hairs on the inner margin, as has the propodus of this leg at the distal inner half. Abdomen unusually large, even to covering the mouth parts when non-ovigerous.

Description of male.—Much smaller, width of carapace less than $\frac{1}{4}$ that of female. Carapace suboctagonal, lightly sculptured, finely pubescent, posterior margin straight. Cardiac region transversely ovate, surrounded by a groove except posteriorly; branchial and gastric regions grooved; a light median sulcus. Front in dorsal view advanced, arcuate, divided; in front view, the front is deflexed and pointed. Orbits oval, eyestalks stout, filling the hiatus. Antennae short. Chelipeds stout, pubescent; carpus short; hands thick; palm with upper surface concave, inner proximal end distended, lower margin of pollex convex from end to end, tip falcate, armed with a tooth and a groove immediately behind it, fingers heavy, gaping when closed, heavily curved at tip, armed with a prominent tooth which meshes into the groove of the pollex. Ambulatory legs similar, slender, slightly pubescent; merus long, cylindrical; propodus convex on both margins; dactylus falcate, slight, long and sharp; carpus and propodus of second and third legs with long fringes of hair on posterior surface. Abdomen with first segment wide at base, widest at third segment, sides converging to tip, seventh segment semi-oval, slightly longer than wide.

Color in life.—The female carapace is a light cream, with an orange red design showing through the cardiac region, and extending on to the branchials. Male, a light brown.

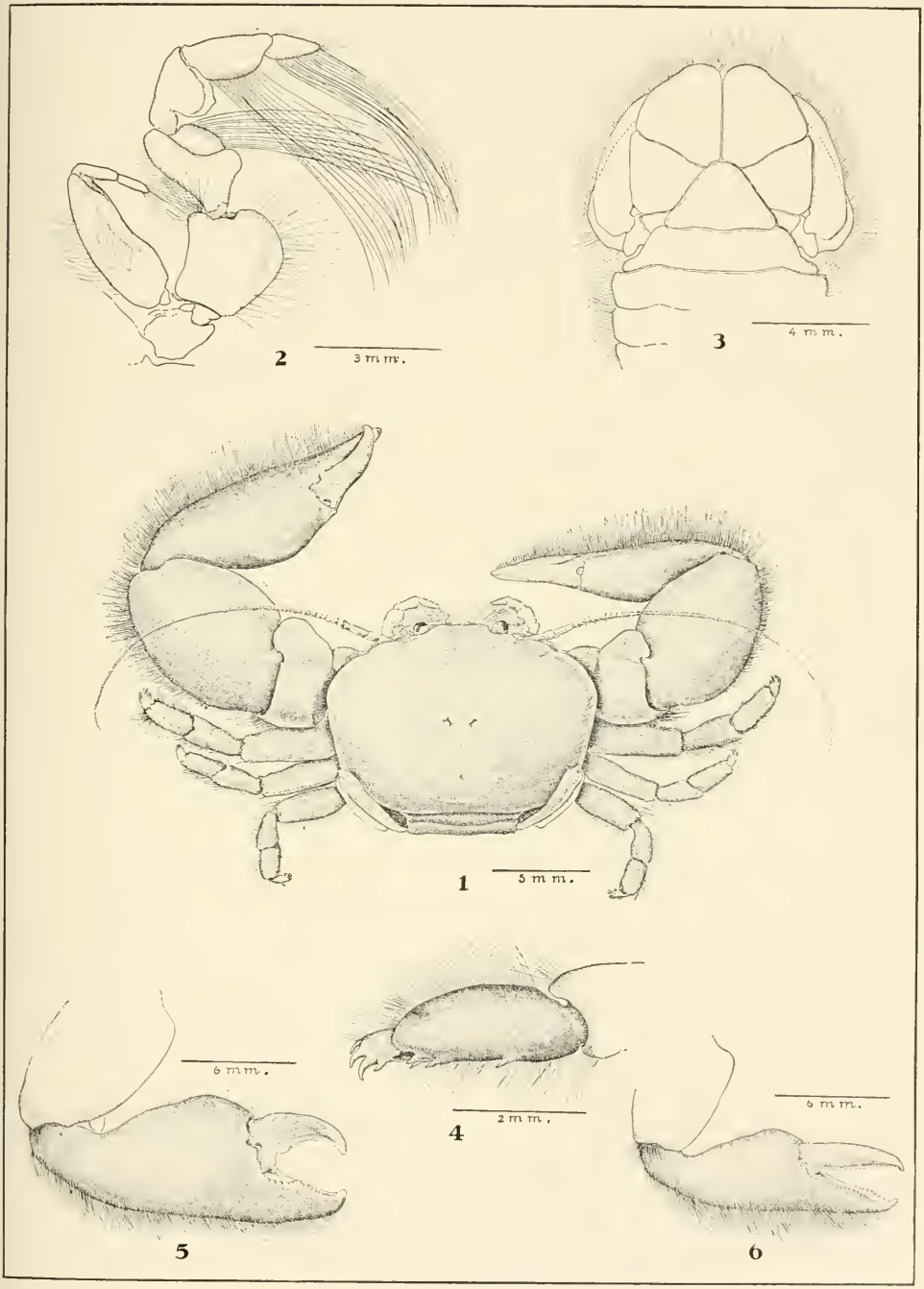
Measurements.—Female holotype: length of carapace 7.6 mm., width 12.4 mm. Male paratype: length of carapace 2.33 mm., width 2.5 mm.

Range.—From Magdalena Bay, Baja California, Mexico, to the head of the Gulf of California.

Material examined.—A series of over two hundred females, taken throughout its range, and five males taken at San Felipe, Baja California, Mexico.

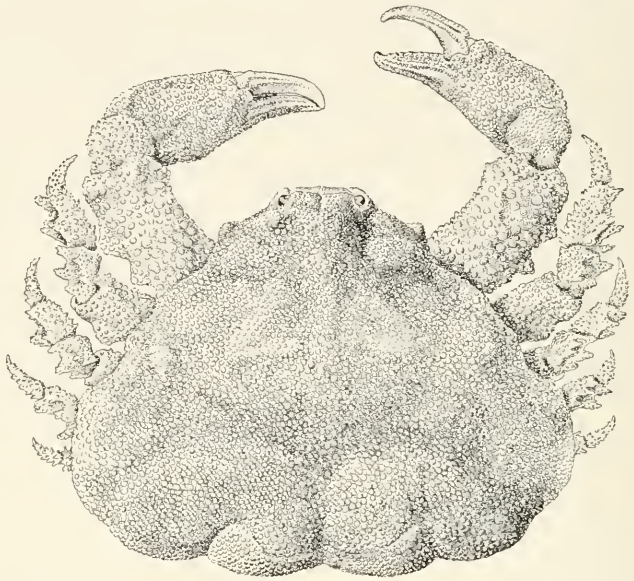
Habitat.—Found commensal in the boring mollusk, *Lithophaga attenuata* (Deshayes), which I have taken from a depth of 15 fathoms to just below the inter-tidal zone.

Remarks.—This species closely resembles *Pinnotheres lithodomi* Smith, 1870, which was described from a damaged juvenile specimen, but differs from that species in the following particulars: Merus of outer maxillipeds convex on anterior margin, convex on distal posterior margin, and thence concave to base, instead of broadest at distal extremity, sides nearly straight; first and second ambulatory legs stout, clavate at distal end of propodus, instead of slender. The distinctive characters of this new species, especially the club-shaped first propodus, which is a striking feature even in juveniles, could hardly have missed the critical eye of such a carcinologist as S. I. Smith, and since he makes no mention of them I am convinced his species was not the one here described as new.

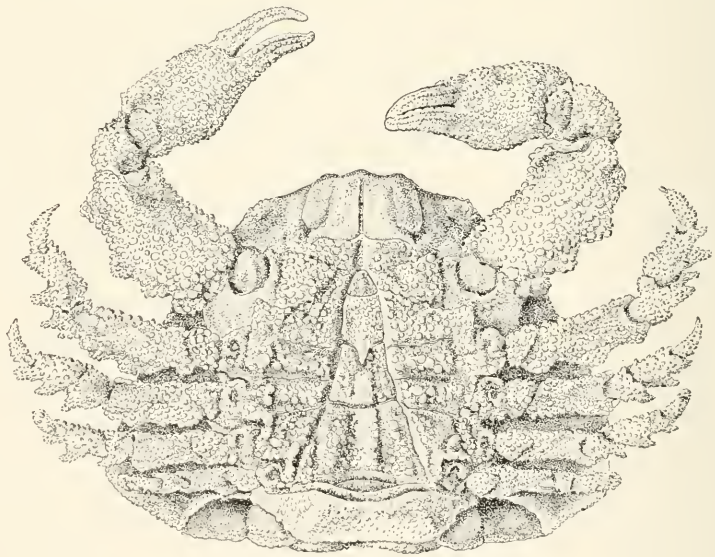


Polyonyx quadriungulatus, n. sp.

Fig. 1. Female holotype, dorsal view.
Fig. 2. Female third maxilliped.
Fig. 3. Female telson of abdomen.
Fig. 4. Propodus and dactyl of ambulatory leg.
Fig. 5. Major chela.
Fig. 6. Minor chela.



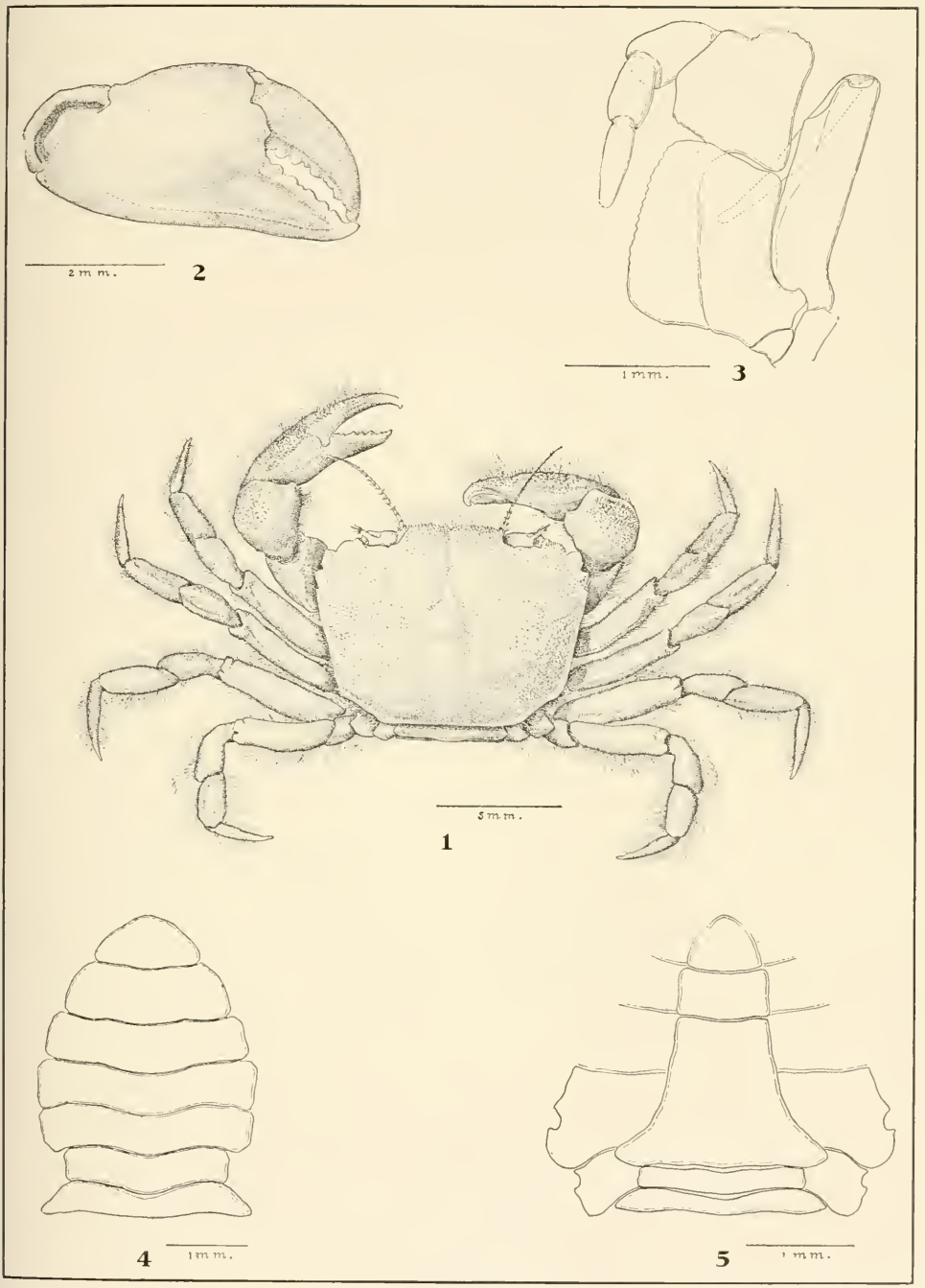
1 10 mm.



2 10 mm.

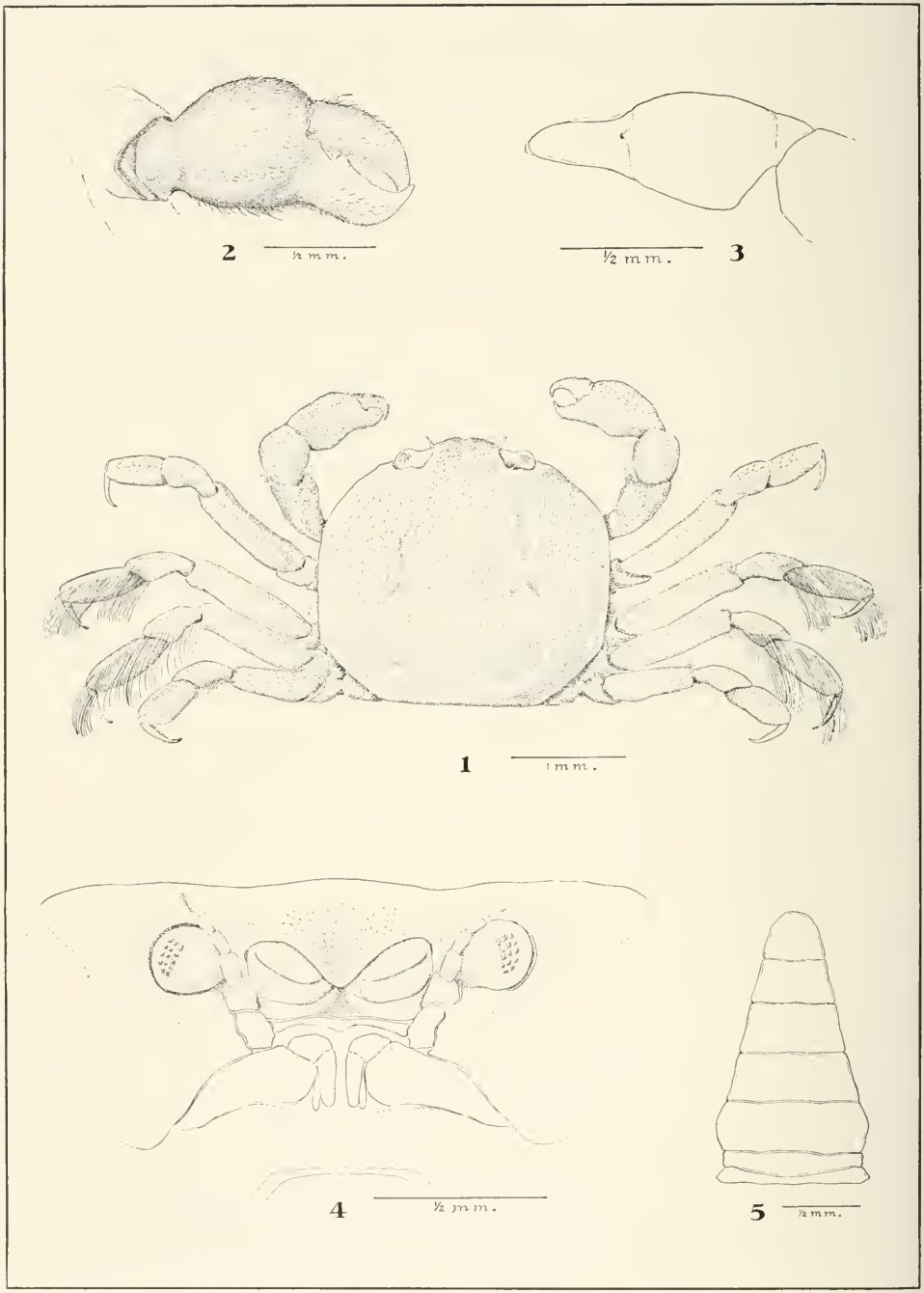
Speloephorus schmitti, n. sp.

Fig. 1. Male paratype, dorsal view. Fig. 2. Male paratype, ventral view.



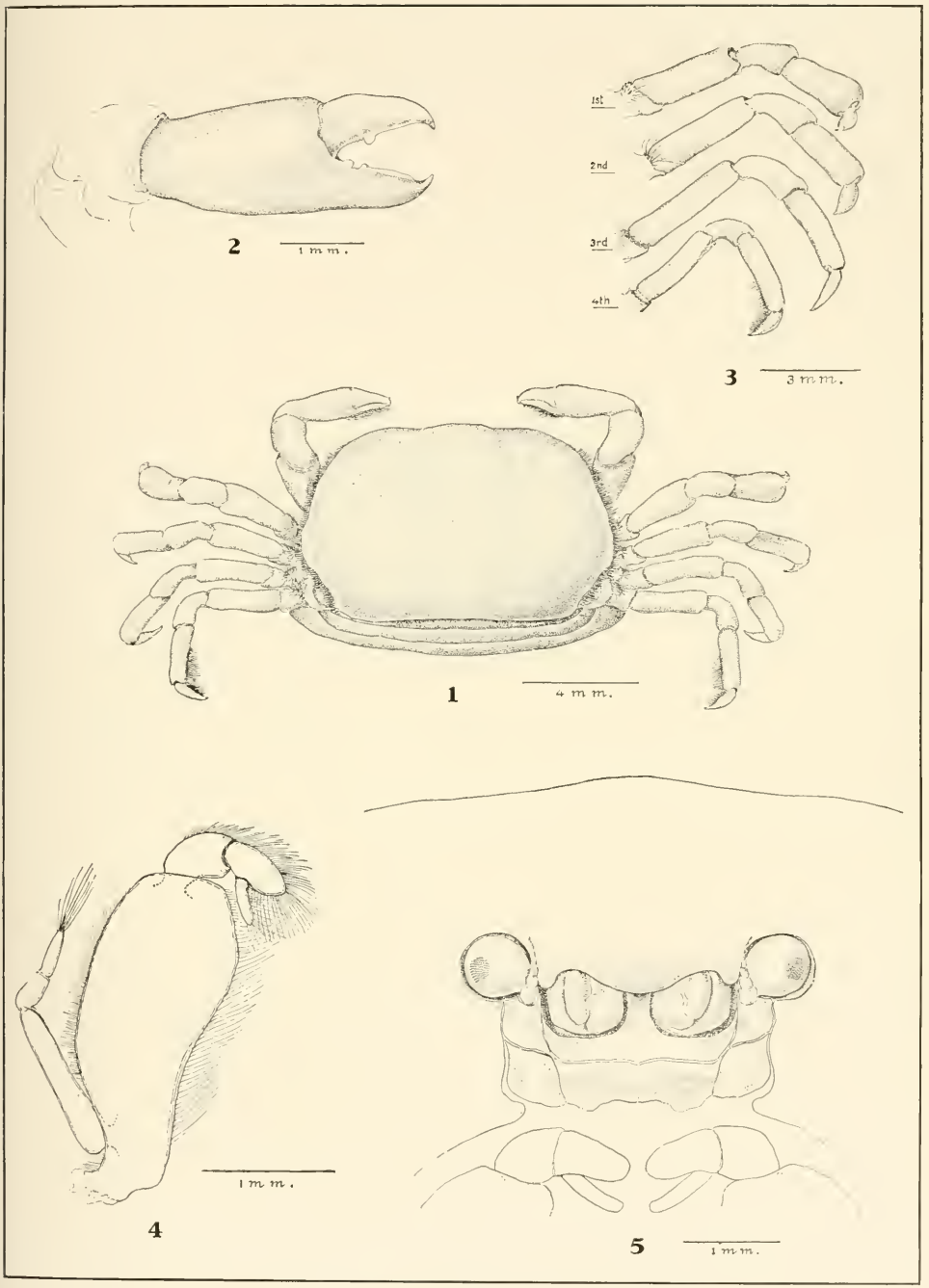
Panoplax mundata, n. sp.

Fig. 1. Male holotype, dorsal view.
Fig. 2. Major chela without hair.
Fig. 3. Outer maxilliped.
Fig. 4. Female abdomen.
Fig. 5. Male abdomen.



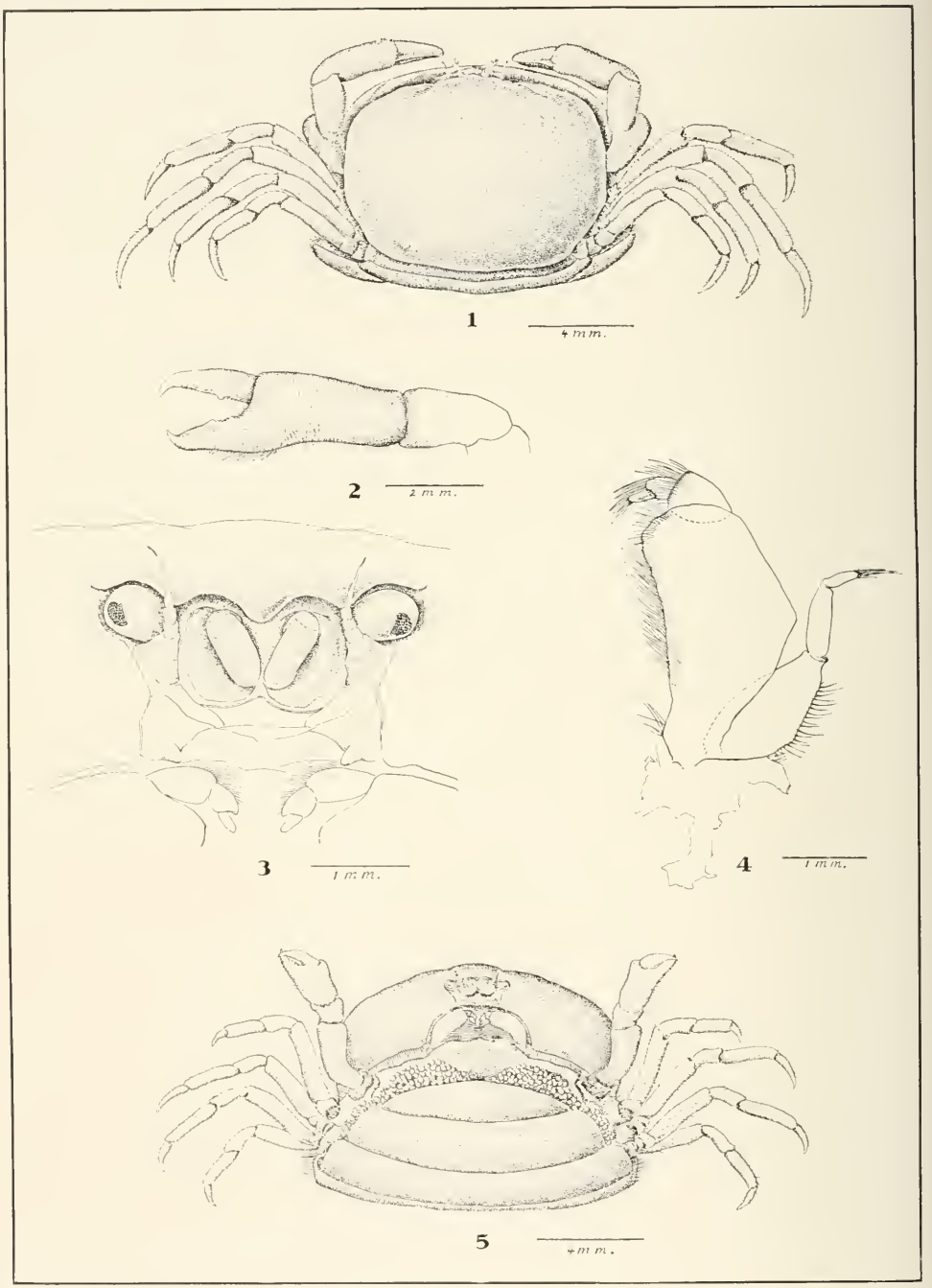
Pinnotheres clavapedatus, n. sp.

Fig. 1. Male paratype, dorsal view.
Fig. 2. Male right chela.
Fig. 3. Male right chela, dorsal view.
Fig. 4. Male antennal and buccal area.
Fig. 5. Male abdomen.



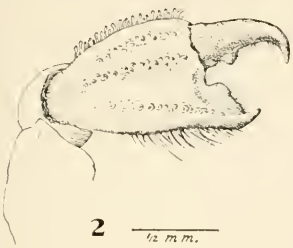
Pinnotheres clavapedatus, n. sp.

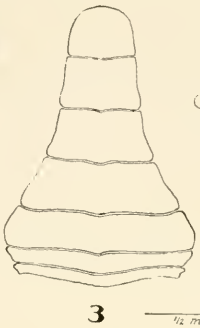
Fig. 1. Female holotype, dorsal view.
Fig. 2. Female, right chela.
Fig. 3. Female, ambulatory legs.
Fig. 4. Female, third maxilliped.
Fig. 5. Female, antennal and buccal area.

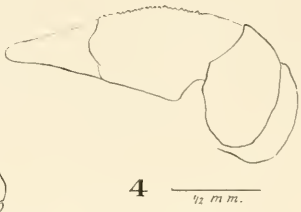


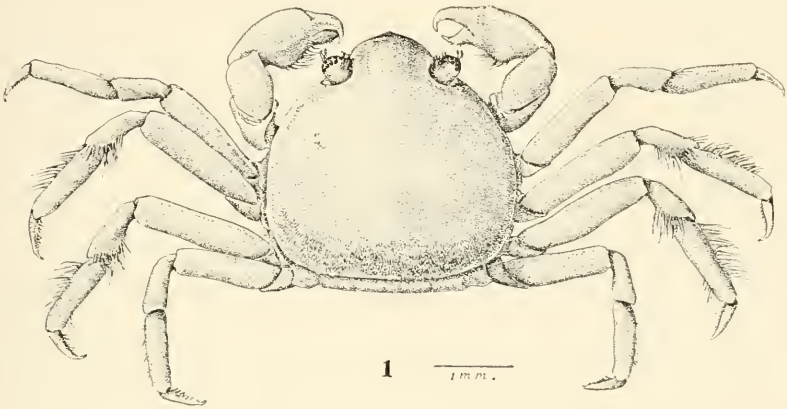
Pinnotheres angelicus Lockington, female.

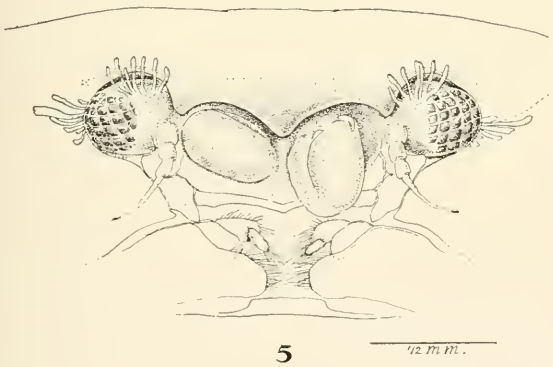
Fig. 1. Female neotype, dorsal view.
Fig. 2. Female chela.
Fig. 3. Female antennal and buccal area.
Fig. 4. Female outer maxilliped.
Fig. 5. Female frontal-ventral view.





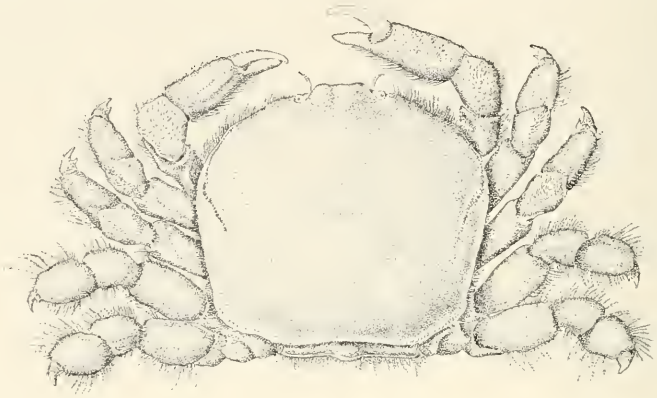




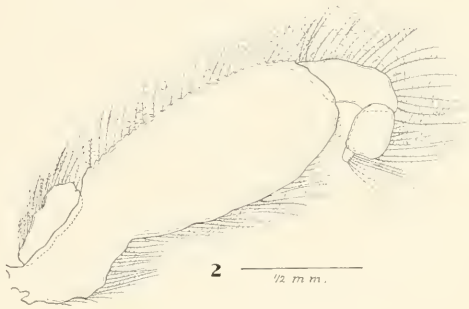


Pinnotheres angelicus Lockington, male.

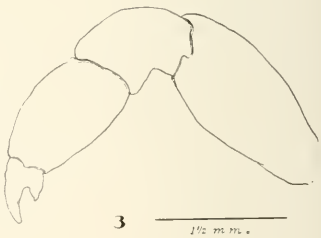
Fig. 1. Male allotype, dorsal view.
Fig. 2. Male chela.
Fig. 3. Male abdomen.
Fig. 4. Male chela, dorsal view.
Fig. 5. Male antennal and buccal area.
Fig. 6. Male chela, front view of palm.



1 3 mm.

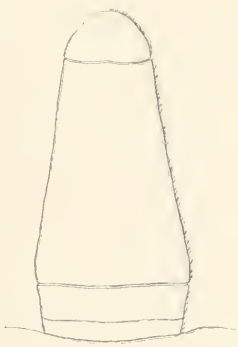


2 ½ mm.

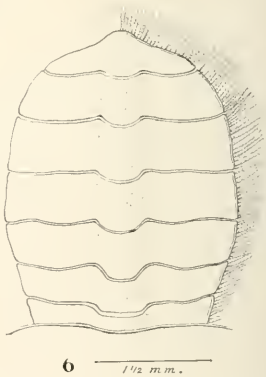


3 1½ mm.

4 ½ mm.



5 1 mm.



6 1½ mm.

Dissodactylus lockingtoni, n. sp.

Fig. 1. Female, dorsal view.
Fig. 2. Female, third maxilliped.
Fig. 3. Female, first ambulatory leg.
Fig. 4. Female, right chela.
Fig. 5. Male abdomen.
Fig. 6. Female abdomen.

Pinnotheres angelicus Lockington

Plates 14, 15

Pinnotheres angelica Lockington, Proc. California Acad. Sci., vol. 7, 1876 (1877), p. 155 [10] (type-locality, Angeles Bay, Gulf of California, in oysters; type not extant). Not *P. angelicus* Miers, Journ. Linn. Soc. London, Zool., vol. 15, 1880. (Rathbun).

Pinnotheres angelicus Lockington, (Rathbun), Bull. U. S. National Museum, No. 97, Jan. 25, 1918, pp. 72-73, pl. 16, figs. 5-6, text fig. No. 34.

This species was found on the Gulf coast of Baja Californa, Mexico, at Angeles Bay, and was described by Lockington in 1877. In 1906 the female holotype and the female paratypes were destroyed in the San Francisco fire. No males were in the original collection.

In January 1932 at Angeles Bay, and in June 1933, at San Felipe, on the Gulf coast of Baja California, Mexico, I took a large series of the females and a few males. From the Angeles Bay material I am designating one female the neotype and one male the allotype.

Neotype.—Female; No. 758, collection of the San Diego Society of Natural History: from Angeles Bay, Baja California, Mexico; January 4, 1932; collected by Steve A. Glassell.

"*Diagnosis.*—Female transverse, smooth, shining. Dactylus of second leg much the longest. Prominent tubercle on basal joint of antennae. Dactylus of endognath attached to end of propodus.

"*Description of female.*—Smooth, shining. Carapace thin, easily wrinkled, transverse, with anterior margin strongly arcuate, posterior margin long, slightly concave, sides rounded; gastric region well defined; a large pit on branchial region near inner angle. Front advanced, edge rounded. Orbits and eyes oval, hidden from dorsal view. A large prominent tubercle at posterior end of basal joint of antenna. Propodus of endognath distally rounded, dactylus small, attached on inner portion of extremity of propodus. Chelipeds elongate, manus slightly compressed and increasing distally; immovable finger slightly deflexed, swollen in basal half: fingers fitting together when closed, tips curved and crossing each other. Legs slender, second longest, third next, fourth shortest; dactyli nearly straight, except that of second leg, which is twice as long as of other legs, and nearly equaling its propodus. Abdomen unusually large." (Rathbun).

Allotype.—Male; No. 759, collection of the San Diego Society of Natural History: from Angeles Bay, Baja California, Mexico; January 4, 1932; collected by Steve A. Glassell.

Description of male allotype.—Much smaller than female. Carapace flat, suborbicular, with the front advanced in a triangle, tip rounding downward to a blunt point, not observable in dorsal view; surface hard, lightly pubescent, punctate; cardiac region faintly defined. Eye stalks large and stout, diminishing from base to tip; pubescent on upper forward surface; cornea large. A small tubercle at posterior end of basal joint of antenna. Chelipeds stout, similar, slightly pubes-

cent, palm smooth, swollen in basal half, decreasing distally; exterior of manus crossed longitudinally by a granulate ridge. Pollex short, stout, hooked at tip; a large ridge-like tooth occupying entire central portion; a deep notch at gape. Dactyli long and curved at tip, armed with two well-developed teeth at proximal end, the distal one the larger; fingers fitting together when closed, curved tips crossing each other; a row of hairs at bottom margin of hand. Legs slender, second and third subequal, first shorter, fourth shortest. Dactyls long and straight, with tips hooked, acuminate. Popodus of last three legs crested with setae. Lower distal edges of carpus of second and third legs with setae. Abdomen widest at third segment which is almost three-quarters of entire length; gradually narrowing from third to seventh segment, which is obtusely rounded. Abdomen and sternum pubescent.

Color in life.—Carapace and chelipeds of male a deep chocolate brown; ambulatory legs much lighter. Carapace and chelipeds of female a deep chocolate brown; ambulatory legs a light cream color.

Measurements.—Female neotype: carapace 8 mm. long, by 11 mm. wide. Male allotype: carapace 2.7 mm. long, by 2.8 mm. wide.

Range.—Gulf of California, Mexico, from upper to lower end.

Habitat.—Found in the mantle cavity of a small plicated oyster which is attached to rocks or mangrove roots, this oyster may prove to be either *Ostrea cumingiana* Dunker, or *O. amara* Carpenter. It is also reported in the mussel *Modiolus capax* Conrad, a series of which I examined at San Felipe, Baja California, Mexico, but without results. The male is undoubtedly free swimming and its capture at any time is highly problematical. Out of several hundred specimens examined, a series of only six or eight males was taken.

Dissodactylus lockingtoni, n. sp.

Plate 16

Type.—Female, holotype; Cat. No. 760, San Diego Society of Natural History; from Punta Peñasco (Rocky Point), Sonora, Mexico, low tide; May 3, 1935; collected by Steve A. Glassell. One paratype, male, Cat. No. 761, S. D. S. N. H.; one paratype female, juvenile, Cat. No. 71339, U. S. National Museum; 25 of both sexes, paratypes, in the collection of Steve A. Glassell, Beverly Hills, California.

Diagnosis.—Carapace convex. Dorsal ridge slightly oblique to postero-lateral border. Upper border of merus-ischium of outer maxilliped serrate; palp three-jointed. Last segment of male abdomen semi-oval.

Description.—Carapace convex in both directions, high in middle, minutely pubescent; regions ill defined, almost smooth. Front concave, slightly produced. Antero-lateral borders arcuate, sinuous, with a milled margin starting at the cervical groove, which at the lateral angles, extends obliquely inward on the carapace; postero-lateral borders with a nearly straight rim; posterior margin sinuous. Merus of outer maxillipeds suboblong, upper crest serrated; lower distal angles rounded; segments of palp long; second segment spatulate, distal end broad and

squarely truncate; third segment small, located at the distal inner angle of the second segment. Merus of chelipeds short, not extending far beyond carapace; carpus short, minutely granulate; hands similar, suboblong, granulate, faint ridges on inner and outer sides, a pubescent fringe on inner lower margin of palm, extending to pollex. Pollex horizontal, unarmed. Prehensile finger longer than pollex, curved, granulate, and armed with three or more small teeth, increasing in size towad the gape. Legs slightly hairy, short, stout; dactyli of first three legs smooth, naked, divided at proximal third, secondary tip short, bifid; dactylus of fourth simple, long, lanceolate, slightly curved at tip, lower margin with long hair to distal third.

Sexual variation.—The female resembles the male. The female abdomen covers the sternum, is suboblong, with seven segments; seventh segment broadly triangular, height less than $\frac{1}{3}$ the width. Male abdomen, first and second segments narrower than third, fused; third to sixth fused, expanded at base, contracted at distal end; first to sixth coffin-shaped; seventh segment semi-oval, height a little more than $\frac{1}{2}$ the width.

Color in life.—Male, bluish-white, with fingers of chelipeds yellowish. Female, carapace pigmented on bluish-white ground with minute dark brownish specks, yellow of internal organs showing through. Ambulatory legs specked with dark spots. Row of black hairs on anterior margin of sternum, in both sexes, partly covering the mouth parts.

Measurements.—Female holotype: length of carapace 7 mm., width 7:5 mm. Male paratype: length of carapace 5.5 mm., width 5.8 mm.

Range.—Found both at San Felipe, Baja California, Mexico, and at Punta Peñasco (Rocky Point), Sonora, Mexico, but undoubtedly ranges throughout the Gulf of California.

Habitat.—Commensal on the ventral exterior surface of the following Echinoids: *Mellita longifissa* Michelin, *Encope micropora* Agassiz, *E. grandis* Agassiz and *E. californica* Verrill. It is usually found, when on the *Encope,* located in the proximal portion of the posterior interambulacral lunule. From this position to a point near the peristome or periproct of the echnoid, the crab clears the actinal spines, thus forming for itself a roadway but little wider than its outstretched ambulatory legs. *D. nitidus* Smith, may also occupy the same echnoid with *D. lockingtoni,* but the former ranges over the entire ventral surface and has no fixed place of abode.

Affinity.—Related to *D. nitidus* Smith, 1870, which it somewhat resembles, but differs in the following respects: carapace convex, instead of compressed; crest of outer maxillipeds serrate, instead of smooth; terminal segment of male abdomen semi-oval, instead of triangular; color bluish-white, instead of purplish brown.

Remarks.—This species is dedicated to Mr. W. N. Lockington, who did such splendid work in West American carcinology during the 1870's and late 1880's, both as a collector and systematist, while with the California Academy of Sciences, at San Francisco, California.

Pinnixa plectrophoros, n. sp.

Type.—Male; Cat. No. 762, San Diego Society of Natural History: from Punta Peñasco (Rocky Point), Sonora, Mexico; May 1, 1935; collected by Steve A. Glassell.

Description.—Allied to *P. retinens.*[1] Carapace three times as wide as long; nearly flat except toward margins, where it slopes gradually downward at lateral angles, abruptly to posterior margin. Antero-lateral margin feebly indicated by minute granules. Orbits of eyes, the eyes and sub-hepatic regions visible in dorsal view. Front not projecting, bilobed, a median sulcus. Two transverse lunate pits at cardiac region; a pit in line with these on mesobranchial region; other regions ill defined. Chelipeds weak, hairy, similar; carpus smooth, with pubescent margins; hands weak, margins parallel, compressed; pollex in line with lower margin of hand, uncolored, microscopically denticulate; dactyl curved, crested with hair, closely fitted to pollex. First and second legs slight, dactyli long, lanceolate; third leg very heavy, dactyl triangular, with two spines near base of anterior side, a posterior propodal spine, a large outward curving spur at distal posterior end of merus, a small blunt spine at its base, two ischial spines; fourth leg very short, slight, hairy, not reaching past merus of third leg, with two ischial spines and a spine on the proximal lower margin of the merus. Male abdomen, first and second segments free, third to sixth fused, seventh segment as in *P. transversalis,*[2] female abdomen with seven segments, covering sternum.

Measurements.—Length of carapace 2 mm., width 6 mm.

Habitat.—Commensal in the sand tube of a species of annelid worm (*Clymenella*).

Remarks.—Fuller descriptions and plates of this and the two following species will be included in a forthcoming partial revision of the genus *Pinnixa* by the writer.

Pinnixa pembertoni, n. sp.

Type.—Male; Cat. No. 763, San Diego Society of Natural History: from San Felipe, Baja California, Mexico; June 19, 1935; collected by Steve A. Glassell.

Description.—Allied to *P. floridana.*[3] Carapace twice as wide as long, convex posteriorly, punctate, sharply rounding at the angles and to the posterior margin. Antero-lateral angle forming a shoulder, the side walls steep and tapering outwardly. Antero-lateral border with a fine granulate ridge. Cardiac and gastric regions slightly raised, a sulcus between, a shallow depression on each side. Front truncate, slightly projecting, pubescent. Eyes large, filling the orbits. Chelipeds similar, strong; merus short, pubescent; carpus smooth on upper surface, margined with pubescence; hands smooth on inner palm, smooth on outer side, with a row of fine hair on upper and lower margins, a longitudinal row from gape to

[1] Bull. 97, U. S. Nat. Mus., 1918, p. 139, pl. 41, figs. 1-2, text figs. 83-84.

[2] Bull. 97, U. S. Nat. Mus., 1918, p. 132, text figs. 75-76.

[3] Bull. 97, U. S. Nat. Mus., 1918, p. 138, pl. 30, figs. 4-7, text fig. 82.

carpus; lower margin sinuous, pollex convex, distal end upturned, armed with three or more triangular blunt teeth; dactyl curved at tip, armed with two or more blunt teeth in center, crested with fine hair, tip not crossing pollex; gape pubescent, open to tip of fingers. First and second legs slight, merus trihedral, dactyli long, slim, straight, lanceolate; third leg heavy, dactyl long, heavy, straight, pubescent, posterior margin of leg heavily pubescent; fourth leg similar but much smaller, dactyl reaching slightly past merus of third leg, pubescent on both margins. Terminal segment of palp of outer maxilliped reaches nearly to base of ischium. Abdomen widest at third segment; fourth, fifth and sixth segments fused, sides sinuous, narrowest at sixth, seventh broader than sixth, broadly rounded at sides, tip truncate.

Measurements.—Length of carapace 3.8 mm., width 7.6 mm.

Habitat.—Commensal with a species of the "lug-worm" (*Arenicola*).

Remarks.—Dedicated to Mr. J. R. Pemberton, of Los Angeles, California, whose generous constructive criticism has been greatly appreciated by the writer.

Pinnixa huffmani, n. sp.

Type.—Female; Cat. No. 764, San Diego Society of Natural History: from Punta Peñasco (Rocky Point), Sonora Mexico; May 4, 1935; collected by Steve A. Glassell.

Description.—Allied to *P. barnharti.*[4] Carapace little wider than long, very convex in both directions, thin, not firm, internal organs showing through, punctate on posterior half, smooth on anterior portion. A faint antero-lateral margin. Sub-hepatic region prominent in dorsal view. Front a wide arc, not projecting. A transverse, narrow sulcus across entire carapace at cardiac-gastric regions. Regions not defined. Eyes not large, cornea small, red pigment. Chelipeds similar, equal; merus long, hairy; carpus long, rounded, smooth; hands very long, compressed, margins sub-parallel, curving inward at distal end, upper margin highest over dactyl, crested with hair, outside of palm smooth; pollex slightly depressed, triangular, sharp pointed, armed with cutting edge; dactyl very heavy at gape, curved downward to a sharp pointed tip, armed with a large tooth at proximal side of middle, very slightly gaping; the fingers when closed cross the tips of their respective pollices on opposite sides from each other. Legs similar, hairy on margins, not compressed, third longest; dactyli long, nearly straight, curved slightly at tip, which is very sharp, corneous; fourth leg long, reaching to propodus of third; dactyl straight. Abdomen semi-globular, punctate, covering sternum and part of maxillipeds. Second and third segments of palp of outer maxillipeds very large, third the longer.

Measurements.—Length of carapace 6.1 mm., width 7.6 mm.

Habitat.—Commensal in a species of the sea cucumber (*Thyone*).

Remarks.—Dedicated to Mr. Earl C. Huffman, of Pasadena, California, conchologist, and a companion on many a mile of mud and sand.

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[4] Bull. 97, U. S. Nat. Mus., 1918, p. 149, pl. 32, text fig. 91.

XANTHIDAE

Ozius tenuidactylos (Lockington), corrected name

Ozius agassizii A. Milne Edwards, should be known as *Ozius tenuidactylos* (Lockington). A careful study of Lockington's original description of this species (Proc. California Acad. Sci., vol. 7, 1876 [1877], p. 98 [4]: type-locality, La Paz, Lower California; type not extant), under the name *Xantho tenuidactylos* nov. sp., and allowance for the obvious reversing of his length and width measurements, shows that Milne Edwards' *Ozius agassizii* (Crust. Reg. Mex., 1880, p. 279, pl. 55, figs. 1-1d: type-locality, Panama; type in M. C. Z.), must be conspecific. Hence *agassizii* being of later date must be suppressed as a synonym.

Extension of Range and New Locality Records

PINNOTHERIDAE

Fabia granti Glassell
San Felipe, Baja, Calif., Mex. June 1, '34 2 ♀ juv.
Host, *Acmaea mesoleuca* Menke
San Felipe, Baja Calif., Mex. June 19, '35 2 ♀
Host, *Crucibulum spinosum* (Sowerby)
Punta Peñasco, Sonora, Mex. May 3, '35 1 ♀
Host, *Crepidula nieva* C. B. Adams
Opisthopus transversus Rathbun
San Felipe, Baja Calif., Mex. June 1, '34 2 ♂ juv.
Pinnixa transversalis (M. Edw. & Lucas)
San Felipe, Baja Calif., Mex. June 1, '34 10 ♂ , 10 ♀
Punta Peñasco, Sonora, Mex. May 2, '35 3 ♂ , 3 ♀
Pinnixa occidentalis Rathbun
San Felipe, Baja Calif., Mex. June 1, '34 6 ♂ juv., 6 ♀ juv.
Pinnixa longipes (Lockington)
Ensenada, Baja Calif., Mex. Jan. 2, '35 1 ♂ , 1 ♀
Pinnotheres reticulatus Rathbun
San Felipe, Baja Calif., Mex. June 19, '35 12 ♀
Host, *Tagelus affinis* C. B. Adams
Host, *Paphia grata* Sowerby

MAJIDAE

Pugettia producta (Randall)
Ensenada, Baja Calif., Mex. Jan. 2, '35 1 ♂

PORTUNIDAE

Portunus (*Portunus*) *xantusii* (Stimpson)
Santa Barbara, California Mar. 17, '33 1 ♂

XANTHIDAE

Lophopanopeus bellus (Stimpson)
San Pedro, California Jan. 8, '33 2 ♂ , 1 ♀
Lophopanopeus bellus (Stimpson) variety
San Pedro, California Jan. 8, '33 2 ♂
Taken at low tide
Glyptoxanthus meandricus (Lockington)
Punta Peñasco, Sonora, Mex. May 2, '35 10 ♂ , 10 ♀
Pilumnus limosus Smith
Punta Peñasco, Sonora, Mex. May 1, '35 10 ♂ , 10 ♀

PORCELLANIDAE

Pachycheles holosericus Schmitt
Ensenada, Baja Calif., Mex. Jan. 3, '35 1 ♂ , 1 ♀
Pachycheles pubescens Holmes
Ensenada, Baja Calif., Mex. Jan. 3, '35 2 ♂ juv., 3 ♀ juv.

28,898

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. VIII, NO. 15, pp. 107-114, text figs. 1-6 AUGUST 24, 1935

A NEW GENUS AND SPECIES OF PIGMY GOOSE FROM THE McKITTRICK PLEISTOCENE[1]

BY

ROLAND CASE ROSS

Los Angeles City Schools

Among the Pleistocene avian remains found by the California Institute of Technology in the asphalts of McKittrick are fourteen (complete and partial) tarsometatarsal elements of a goose more slender than any of the living Anserinae. Without attempting at this time to establish the identity of the form on the basis of other elements, it is here proposed to describe and record a new genus and species of goose on tarsal characters alone, the tarsus being a characteristic avian element, and in this instance well preserved, numerous and clearly generically distinct.

ACKNOWLEDGMENTS

Thanks are due Dr. Loye Holmes Miller for suggesting the problem and for use of material.

Mr. John L. Ridgway, scientific illustrator of the California Institute of Technology, is acknowledged gratefully for the preparation of text figures.

Dr. Chester Stock, in whose laboratory this study has been made, is thanked for continued encouragement and guidance.

Anabernicula gracilenta, n. gen. and n. sp.

Type.—No. 1169 Calif. Inst. Tech. Vert. Pale. Coll., left tarsometatarsus of

[1] Contribution No. 171. Balch Graduate School of the Geological Sciences, California Institute of Technology.

mature Anserine bird, complete and unworn, from the brea deposits of McKittrick, Calif., Pleistocene age.

Paratypes.—No. 1168, right tarsometatarsus, complete except for extended portions of hypotarsus, length 60.3 mm.; and No. 1170, left tarsometatarsus, proximal three-fifths.

Description.—Goose-like in general structure and proportions. Small and slender with delicately tapered shaft, broad spread of distal condyles, and diminished tarsal articulation.

Inner cotyla deeply cupped and of noticeably *slight extent anteroposteriorly.*[2]

Hypotarsus in lateral aspect rectangular, of relatively slight vertical extent, markedly strong in plantar depth. Inferior terminus of inner calcaneal ridge abrupt, with *slight gradient into shaft.*

Intermuscular line of the posterointernal border of shaft *deflected* inwardly toward the proximal end, effecting thus a disjunction with the inner calcaneal ridge. Extensor groove flattens out in its oblique descent across inner surface of shaft and weakens intermuscular line at junction.

Measurements of Type in Millimeters

Total length over all	61.8
Minimum shaft width (transverse)	4.4
Minimum shaft depth (anteroposterior)	3.4
Minimum shaft area, cross section (sq. mm.)	14.96
Transverse width proximal end	11.6
Anteroposterior depth proximal end (inner cotyla)	5.5
Anteroposterior depth proximal end including hypotarsus	11.0
Anteroposterior depth first calcaneal ridge	5.5
Transverse (total) extent of distal end (condyles 2, 3, 4)	10.4
Transverse extent of condyles 3 and 4	8.4
Minimum transverse width of condyle 2	2.9
Maximum transverse width of condyle 3	5.0
Mean transverse width of condyle 4	3.6
Anteroposterior depth of condyle 2	5.6
Anteroposterior depth of condyle 3	7.2
Anteroposterior depth of condyle 4	7.1
Minimum transverse width of prong shaft to condyle 4, taken from distal foramen to outer border	3.2

Generic Characters of Anabernicula

Although assignable only to the subfamily Anserinae or true geese, there are characters consistently present in the fossil tarsal specimens that relate to ducks and tree-ducks, Anatinae and Dendrocygninae respectively. Chief among these are the square-cornered outline of the hypotarsus as viewed from the inner side, its undercut effect at the distal confluence with

[2] Anteroposterior is the rotular-plantar axis.

shaft, and its marked plantar extent. Fig. 1A shows these distinctions in contrast to the characters seen in species of living pigmy geese (fig.1, B, C, D). Of 24 races of geese studied, none displays the above characters, while ducks and tree-ducks both possess them.

The deflection of the intermuscular line internolateral of the hypotarsus is a strong dendrocygnine structural feature, as is also the strap-like groove for the muscle *extensor hallucis brevis* upon the inner side of the shaft. In the Anserinae the groove is fine or cord-like as opposed to ribbon or strap-like in tree-ducks. This character in the fossil bird is intermediate, being fine-grooved proximally but widened distally on the approach to the intermuscular line. An unique feature is the flattening or weakening effect this has on the intermuscular line at this junction. This effect has not been noted in ducks (excepting the Muscovy Duck) or tree-ducks, and is only weakly if at all defined in geese

Proximal view of the head (fig. 1A upper) shows a more restricted articulation area as compared with that in other geese (actual and relative), an excessive development of the first calcaneal ridge anteroposteriorly, and a small circular deeply cupped inner cotyla of limited anteroposterior diameter.

The above structural features deserve generic distinction, while the following goose-like characters maintain the status of the new group within the Anserinae: The tapering and proportions of the shaft eliminate Cygninae, Anatinae, Dendrocygninae and are typical of Anserinae. The swelling of shaft into condylar prongs, the spacing, and the total spread of the distal condyles are separable by detail or proportion from all others but the Anserinae.

Specific Characters of Anabernicula gracilenta

Anabernicula gracilenta as a species can be "hand picked" from mingled tarsi of other pigmy geese by an appearance of delicacy and dwarfness. The ranges in size of its component parts as given below are considered fair delimitation for the species, inasmuch as the number of fossil specimens equaled or surpassed Recent specimens of each species studied. Both mature and immature individuals were present.

The seventeen fossil specimens of tarsometatarsus fall into a very consistent clustered group when measured in certain ways. Various units of study and ratios between measurements give specific and even generic distinctness to the fossil group. In the living pigmy geese no such sharpness

between groups and rarely any tendency to generic separation has appeared in the numerous measurements and ratios exacted of their tarsi.

There are, however, size and proportional figures that yield no distinctions between *Anabernicula gracilenta* and the four pigmy races of native geese. Such characters are frequently of subfamily rank, inasmuch as they unite the goose group and serve to distinguish it from Anatinae, Cygninae, and Dendrocygninae.

Life Characteristics

This small goose outnumbers several times over the individuals of other geese occurring in the McKittrick collections of the California Institute. The larger geese are noticeably infrequent in this and other collections of McKittrick material. The relative abundance of the pigmy goose would seem to indicate special attractiveness of the locality as afforded perhaps by shallow ponds and mud flats.

Anabernicula gracilenta possesses more slender proportions than any known goose, and is smaller in bulk and weight than any goose living with the exception of *Chenonetta* of Australia.

The resemblance of the fossil goose to *Branta bernicla* in length of tarsometatarsus and in some other gross features leads one to picture the extinct waterfowl as of similar but slighter build than the black or sea brant. Standing in equal height of limb, *A. gracilenta* weighed much less than the brant, probably approaching the tree-duck in weight.

The spread of the distal condyles for digital articulation, while distinctly goose-like and not duck-like, nevertheless falls away from the goose type when considered in proportion to length of shaft. In this regard it joins in close proportional similarity to the tree-ducks. *Chloephaga,* the upland goose, noted for its terrestrial habits, favors this narrow foot and long shaft proportion. It is significant that this proportional study throws sharp distinction between the fossil goose and the goose nearest it in size, namely *Branta bernicla,* while at the same time placing it nearer to *B. c. minima* and *C. rossii.* The latter two geese spend a considerable part of their lives upon the land, while *Branta bernicla* is a marine forager that spends little time ashore. It might be further pointed out that *Philacte canagica,* our most maritime goose, shows an extreme disproportion toward short shank and wide foot, and that the swan (*Cygnus columbianus*), strongly aquatic, falls well within the same grouping.

Considering the characters, slender shaft, length of shaft, small proximal weight-bearing articulation, reduced spread of digital condyles,

and considering the inference given above as based upon the ratio of foot-spread to tarsal length, this BREA PIGMY GOOSE appears in mind as an agile, light-bodied goose of active, walking habits frequenting, in company with shorebirds, mud flats and borders of ponds.

Anabernicula (Anas-bernicla, duck-goose) denotes the relationship of the new goose genus, while *gracilenta* denotes the delicacy and grace suggested in many features by the specimens at hand.

FAUNAL RANGE

In the fossil collections of the University of California at Los Angeles there are six tarsi of pigmy geese: two from Rancho La Brea, three from McKittrick, and one from Fossil Lake, Oregon. These were shown to me in 1931 by Dr. Loye Holmes Miller, who kindly permitted the study of them.[3] One of the two "pigmy geese" cited from Rancho La Brea as *Branta*(?) sp. by Miller[4] and two from McKittrick referred to the *Chen hyperboreus* group of the same author[5] classify readily as *Anabernicula gracilenta*. The Fossil Lake specimen, however, is not referable to the latter form.

Branta minuscula, described by Alexander Wetmore[6] from a proximal half of a humerus presents characteristics which might be expected in humeri of *A. gracilenta*. If the geologic position of *Branta minuscula* is Upper Pliocene, as determined by J. W. Gidley, considerable difference in age prevails between these two similar forms from Arizona and Southern California.

SUMMARY

A total of sixteen tarsometatarsal elements of a small goose from the Pleistocene asphalts of McKittrick and one specimen from Rancho La Brea furnish the basis for establishing a new genus of goose. In certain characters, as displayed in the regoin of the hypotarsus and on the inner extensor groove, this form shows resemblance to the tree-ducks. The species represented is smaller than *Branta bernicla* and evidently more slender than any living goose.

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[3] MILLER, LOYE H. A second avifauna from the McKittrick Pleistocene: The Condor, vol. 37, p. 76, 1935.

[4] MILLER, LOYE H. The birds of Rancho La Brea: Carnegie Inst. Wash. Publ. No. 349, p. 73, 1925.

[5] MILLER, LOYE H. Avifauna of the McKittrick Pleistocene: Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 15, No. 9, pp. 314, 315, 1925.

[6] WETMORE, ALEXANDER. Fossil birds from southeastern Arizona: Proc. U. S. Nat. Mus., vol. 64, art. 5, pp. 6-7, 1924.

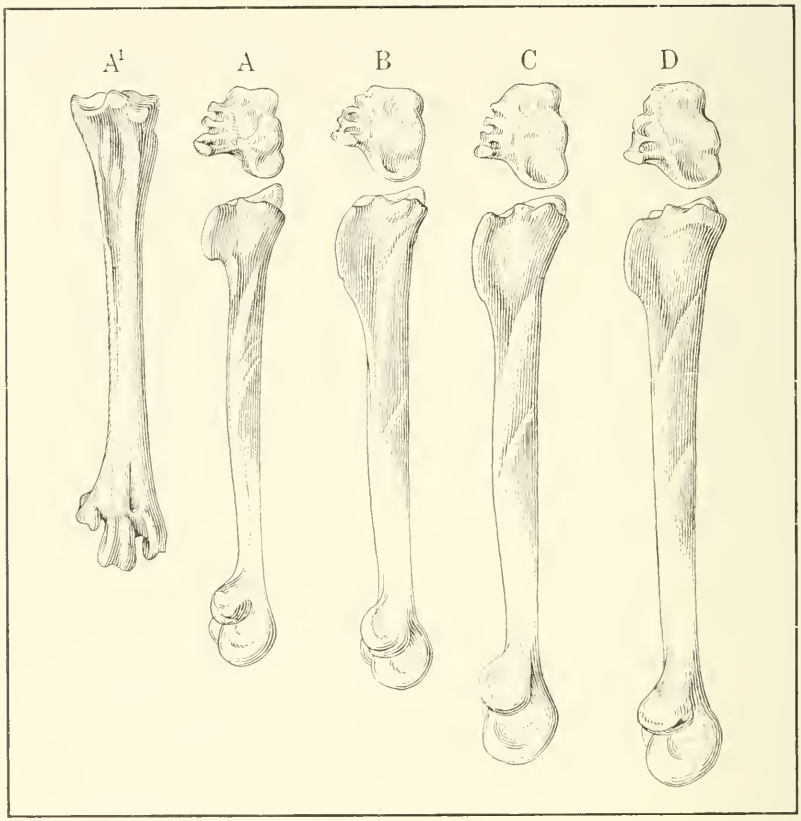


Fig. 1. Right tarsometatarsi of pigmy geese. Natural size.

A1. **Anabernicula gracilenta,** Type, anterior view.

A. **Anabernicula gracilenta,** Type, inner lateral and proximal views.

B. **Branta bernicla hrota,** inner lateral and proximal views.

C. **Branta canadensis minima,** inner lateral and proximal views.

D. **Chen rossii,** inner lateral and proximal views.

KEY TO FIGURES ON PAGE 113

Fig. 2. Total length of tarsometatarsus.
Extensions beyond arrows indicate extremes listed in standard texts for tarsal lengths in skin specimens. In C (*B. c. minima*) skin measurements taken by author have been added to skeletal series.

Fig. 3. Inner cotyla, proximal end, anteroposterior depth.

Fig. 4. Articulation area proximal end. Transverse width x cotyla depth (anteroposterior).

Fig. 5. Maximum depth condyle 4 (anteroposterior).

Fig. 6. Ratio of anteroposterior depth of inner proximal cotyla (Fig. 3) to anteroposterior extent of inner calcaneal ridge.

A. **Anabernicula gracilenta.**
B. **Branta bernicla** (2 races).
C. **Branta canadensis minima.**
D. **Chen rossii.**

Fig. 2.

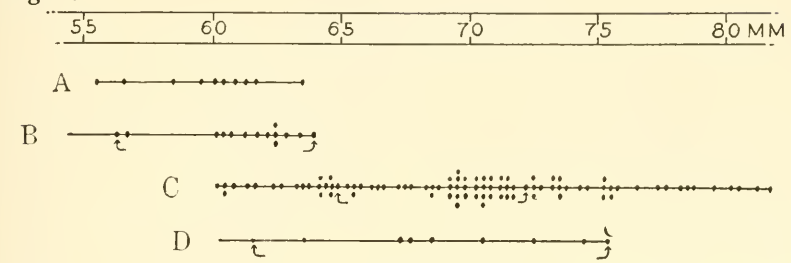


Fig. 3.

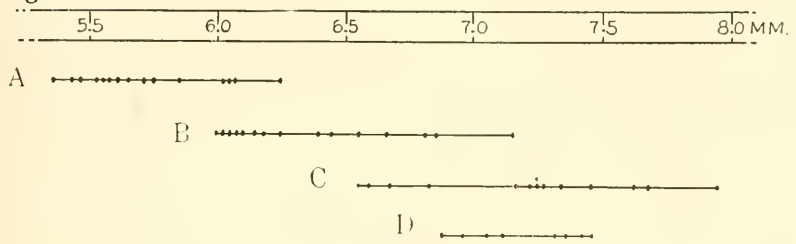


Fig. 4.

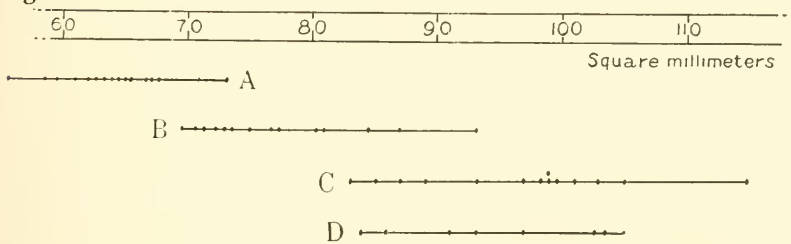


Fig. 5.

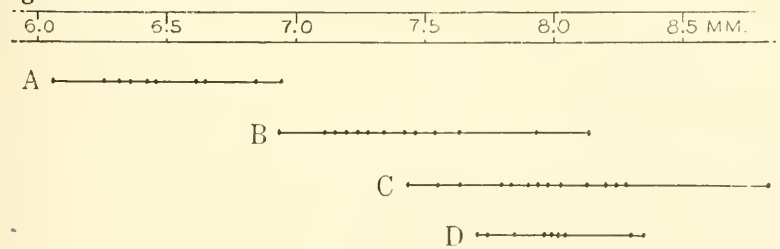
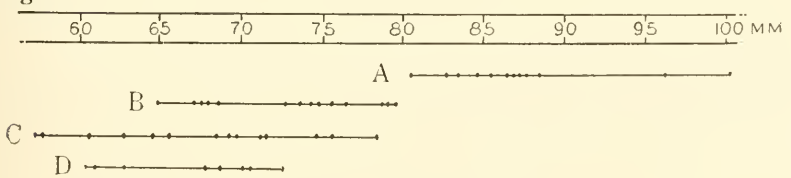


Fig. 6.



Explanation of figures will be found on opposite page.

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

Vol. VIII, No. 16, pp. 115-118 March 12, 1936

DESCRIPTION OF A RACE OF MYIARCHUS CINERASCENS FROM EL SALVADOR

BY

A. J. van Rossem

San Diego Society of Natural History

Studies in this rather complex genus of flycatchers have received impetus through various papers published since the comprehensive revisionary work of Ridgway (1907) and Hellmayr (1927). Chief, perhaps, of the problems which have been discussed are the relationships of *Myiarchus nuttingi* and *Myiarchus inquietus* to *Myiarchus cinerascens cinerascens*. Although the two most recent writers (van Rossem, 1931, and Griscom, 1932 and 1934) are now in substantial agreement that *cinerascens, inquietus,* and *nuttingi* are conspecific, there remains considerable uncertainty as to the manner of intergradation. In this regard I can only reiterate that in Sonora *cinerascens* intergrades gradually and in perfectly conventional manner with *inquietus*. In regard to the behavior of these two forms in Guerrero I am not convinced, after an inspection of the same series that Griscom has studied from that State, that the collector has not mistaken belated migrants or non-breeding individuals of *cinerascens* for residents. It would appear most improbable that the geographic behavior of these two races should be so different in two far separated regions unless it be that *cinerascens* extends a great deal further south in the interior highlands than has heretofore been suspected.

It may be appropriate to note here that a personal examination of the type of Salvin and Godman's *Myiarchus inquietus* in the British Museum

shows it to be without question a perfectly typical example of the race to which the name has currently been applied. It is a female in fresh fall plumage, collected at Acaquizotla, Guerrero (alt. 3500 feet) by Mrs. H. H. Smith on October 18, 1888. In addition to the somewhat yellower and richer coloration, as compared with *cinerascens,* it possesses the pronounced dusky shaft streak on the inner webs of the outer rectrices which, in part, distinguishes *inquietus* from *nuttingi,* but this streak does not expand terminally as in *cinerascens.* The measurements of the type (Brit. Mus. 99-4-20-1479) are: wing, 85.5; tail, 82.5; culmen from base, 21.5; tarsus, 20.1; middle toe minus claw, 13.2 mm.

Mr. Griscom has recently (1932) called attention to certain peculiarities in a series of *Myiarchus "nuttingi"* from the Pacific slope of Guatemala, and has suggested that possibly they are subspecifically distinct from true *nuttingi* of northwestern Costa Rica and western Nicaragua. For several years there has been a series of twelve specimens from El Salvador in the Dickey collection which are obviously neither *inquietus* nor *nuttingi,* but for various reasons it has been deemed advisable to delay the bestowal of a formal name until now. Several years ago I compared this Salvador series with Griscom's Guatemala material (in part) and concluded that the two lots were racially identical, though the Guatemala birds averaged slightly paler. A diagnosis of the new race follows.

Myiarchus cinerascens flavidior subsp. nov.

Type.—Male adult in fresh fall plumage, no. 15,556 Dickey collection; Lake Olomega, Depto. San Miguel, El Salvador, August 26, 1925; collected by A. J. van Rossem, original no. 8626.

Subspecific characters.—Differs from all known forms of *Myiarchus cinerascens* in richness and brightness of coloration; in this respect it is a striking duplicate of *Myiarchus crinitus,* save that the throat and chest of *flavidior* are slightly paler than in *crinitus.* Differs, further, from *nuttingi* in possessing a broad, well defined dusky stripe along the shafts (on the inner webs) of the lateral rectrices and in being very slightly larger. Besides the brighter and richer coloration, *flavidior* differs from *inquietus* in definitely smaller size.

Range.—Lowlands of El Salvador and the Pacific coast of Guatemala.

Remarks.—The relatively intense coloration, which in *flavidior* attains the yellowest underparts and brownest upperparts displayed by the species *cinerascens,* is not dependent on season, for the remarkably uniform series was collected at various seasons throughout the year. This race is resident in El Salvador but is nowhere common. I did not encounter it above an elevation of 1500 feet.

MEASUREMENTS OF MYIARCHUS CINERASCENS FLAVIDIOR

Extremes and Averages in Millimeters

	Wing	*Tail*	*Culmen from Base*	*Tarsus*	*Middle Toe minus Claw*
7 *males*	83-85	79.85	19.6-21.7	20.0-21.5	11.3-12.5
	(84.1)	(81.6)	(20.9)	(21.0)	(11.8)
5 *females*	78-82	77-81	19.5-20.4	19.7-21.2	10.8-12.2
	(80.5)	(78.2)	(20.0)	(20.4)	(11.5)

For the various conceptions of the relationships of the forms mentioned in this paper, reference may be made to the following publications:

NELSON, E. W.

1904. A revision of the North American mainland species of *Myiarchus*. Proc. Biol. Soc. Wash., 17, 1904, pp. 21-50.

RIDGWAY, R.

1907. The birds of North and Middle America. Bull. U. S. Nat. Mus., No. 50, Part 4, pp. 625-632.

HELLMAYR, C.

1927. Catalogue of birds of the Americas [etc.]. Field Mus. Nat. Hist., Zool. Ser., Part 5, pp. 160-161.

VAN ROSSEM, A. J.

1931. Report on a collection of land birds from Sonora, Mexico. Trans. San Diego Soc. Nat. Hist., 6, No. 19, pp. 260-261.

GRISCOM, L.

1932. The distribution of bird-life in Guatemala. Bull. Am. Mus. Nat. Hist., Vol. 64, pp. 253-254.

GRISCOM, L.

1934. The Ornithology of Guerrero. Bull. Mus. Comp. Zoöl., 75, No. 10, pp. 386-388.

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. VIII, No. 17, pp. 119-120 MARCH 12, 1936

A NEW PELECYPOD GENUS OF THE FAMILY CARDIIDAE

BY

A. MYRA KEEN
Stanford University

An evaluation of the pelecypod family Cardiidae (summarized elsewhere[1]), by means of a graphic comparison of the genotypes of the fifteen principal named groups, indicates the desirability of erecting a new genus. None of the genotypic species examined exhibits the distinctive characters which constantly appear in the Northwest American cardiids hitherto, though incorrectly, classified as *Cerastoderma*. The purpose of this preliminary note is to validate a name used in manuscript; detailed discussion of the species included in the genus is withheld for a monographic study whose publication may be considerably delayed.

CLINOCARDIUM Keen, new genus

Genotype: *Cardium nuttallii* Conrad, 1837

Description.—Shell medium to large, trigonal, oblique, usually ventricose; beaks recurved, prosogyrate; position of the umbones varying with age but usually at two-thirds the distance between posterior and anterior ends of the shell; dorsal margin very broadly arched, sloping downward at an angle of about 25°, ventral and anterior margins broadly rounded; epidermis closely adherent, brownish; sculpture of 28 to 55 rounded radial ribs and concentric growth lines which may cross the ribs as conspicuous loops, never as spines; lunule when present circumscribed, never impressed; escutcheon inconspicuous; ligament in dorsal view long, narrow, and oval. Interior porcellaneous, ventral and anterior margins crenulate; hinge arched; cardinals in each valve slightly nearer anterior than posterior laterals; anterior cardinal of left valve stronger than posterior, recurved, posterior cardinal

[1] KEEN, A. MYRA, Revision of Cardiid Pelecypods; Proc. Geol. Soc. Amer. for 1935 (1936). Preliminary abstracts, Dec., 1935, p. 61.

of right valve stronger than anterior, also recurved; ligament not elevated on a short, shelly platform; beaks originating at a point slightly anterior to the anterior cardinals; muscle scars large; pallial line simple. Specimens range in length up to about 120 mm.

Remarks.—*Clinocardium* is distinguished from its nearest relative, *Cerastoderma*, by the markedly forward-pointing beaks, the long, narrow, low ligament, the arched hinge-line, and the greater number of ribs. From *Laevicardium* it is distinguished by the presence of elevated ribs and by the long, depressed ligament.

Clinocardium nuttallii (Conrad)

Cardium nuttallii Conrad, Jour. Acad. Nat. Sci. Phila., vol. 7, 1837, p. 229, pl. 17, fig. 3.

"*Cardium corbis* (Martyn)" of West Coast authors; (not *Corbis* Martyn, Univ. Conch., Tab. 2, fig. 80, 1788).

Type locality.—A few miles from the estuary of the Columbia River.

Repository of holotype.—Academy of Natural Sciences, Philadelphia; Catalogue No. 54036.

The name *Cardium corbis* (Martyn) is unavailable for two important reasons: First, as Winckworth[2] has pointed out, Martyn's *Universal Conchologist* is not consistently binomial and hence is to be rejected. Second, the identification of the West American species with that figured by Martyn is erroneous, a fact recognized by Conrad[3] in 1869. The first available name, therefore, is *nuttallii* Conrad, 1837.

Other Species of Clinocardium

The following tabulation lists all of the other species which have been determined to be *Clinocardium*. Several Japanese Tertiary species will probably prove to belong here, as well as some two or three unnamed species from the Tertiary of California.

Species	*Type Locality*	*Age*
blandum (Gould) 1850	Puget Sound, Washington	Recent
bülowi (Rolle) 1896	Yokohama, Japan	Recent
californiense (Deshayes) 1839	(Of lectotype) Kamtschatka; (Of description) "Mers de Californie"	Recent
ciliatum (Fabricius) 1780	Greenland	Recent
coosense (Dall) 1909	Coos Bay, Oregon; "Miocene"	Pliocene
comoxense (Dall) 1900	Vancouver Island, B. C.	Pleistocene
decoratum (Grewingk) 1850	Aleutian Islands, "Jüngsten Tertiärzeit"	Pleistocene?
fucanum (Dall) 1907	Juan de Fuca Strait	Recent
meekianum (Gabb) 1866	Eagle Prairie, Humboldt County, California, Pliocene	Pliocene
yakatagense (Clark) 1932	Yakataga formation, southern Alaska, "Upper Oligocene"	Pliocene?

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2 Winckworth, R., Notes on nomenclature; Proc. Mal. Soc. London, vol. 18, pt. 5, July, 1929, pp. 228-229.

3 Conrad, T. A., Notes on Recent Mollusca; Amer. Jour. Conch., vol. 5, pt. 2, 1869, p. 105.

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME VIII, No. 18, pp. 121-148, plates 17-18, maps 1-3

NOTES ON BIRDS IN RELATION TO THE FAUNAL AREAS OF SOUTH-CENTRAL ARIZONA

BY

A. J. VAN ROSSEM

San Diego Society of Natural History

SAN DIEGO, CALIFORNIA

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Fig. 1. Lower Sonoran Plains along the north-east slope of the Atasco Mountains; the Tumacacori Mountains in the distance.

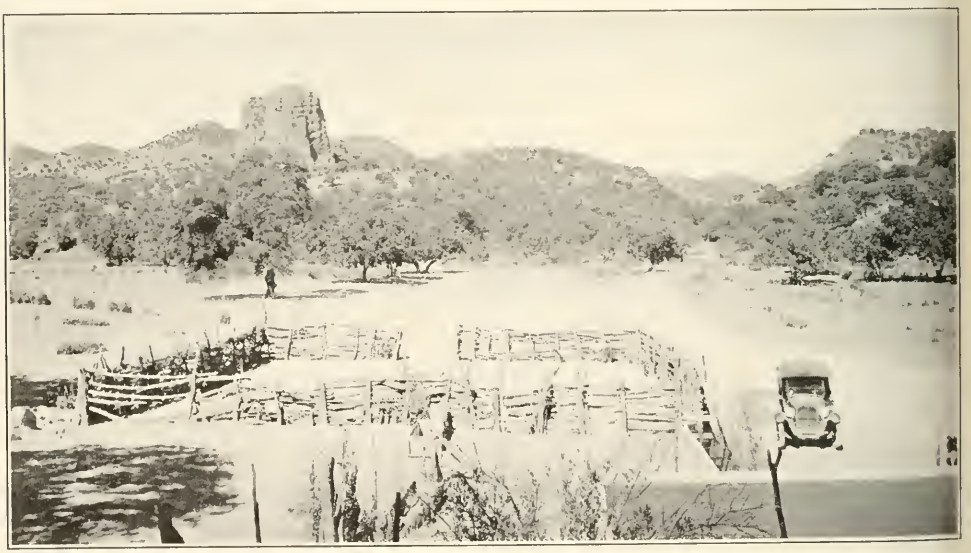


Fig. 2. Peña Blanca Spring in the Pajarito Mountains, Santa Cruz County. Elf owls, spotted screech owls, and Mexican screech owls have been found to be common in this locality.

NOTES ON BIRDS IN RELATION TO THE FAUNAL AREAS OF SOUTH-CENTRAL ARIZONA

BY

A. J. VAN ROSSEM

San Diego Society of Natural History

In the spring of 1931 I suggested to the late Donald Dickey, at that time my chief at the California Institute of Technology, that certain investigations be carried on along the Arizona-Sonora border west of Nogales. The ends sought were: (1) that the radically differing opinions of Mearns and Swarth as to the limits of certain faunal areas west of the Santa Rita Mountains might be brought into some sort of agreement, and (2) that a better understanding of the faunal areas of northern Sonora would be an inevitable result of such work. Mr. Dickey at once acquiesced and accordingly Dr. W. H. Burt, then mammalogist at the California Institute, and the writer arrived in south-central Arizona on April 23. Our first base was at Continental on the Santa Cruz River. From this station we worked south (including the west slope of the Santa Ritas) to Tumacacori and Nogales and thence west, including the Atasco and Pajarito Mountains, to the east slope of the Baboquivaris. Later in the season (on May 29) we returned to the Santa Ritas and worked for some few days in Madera Cañon—from about 4500 feet to the summit of the range.

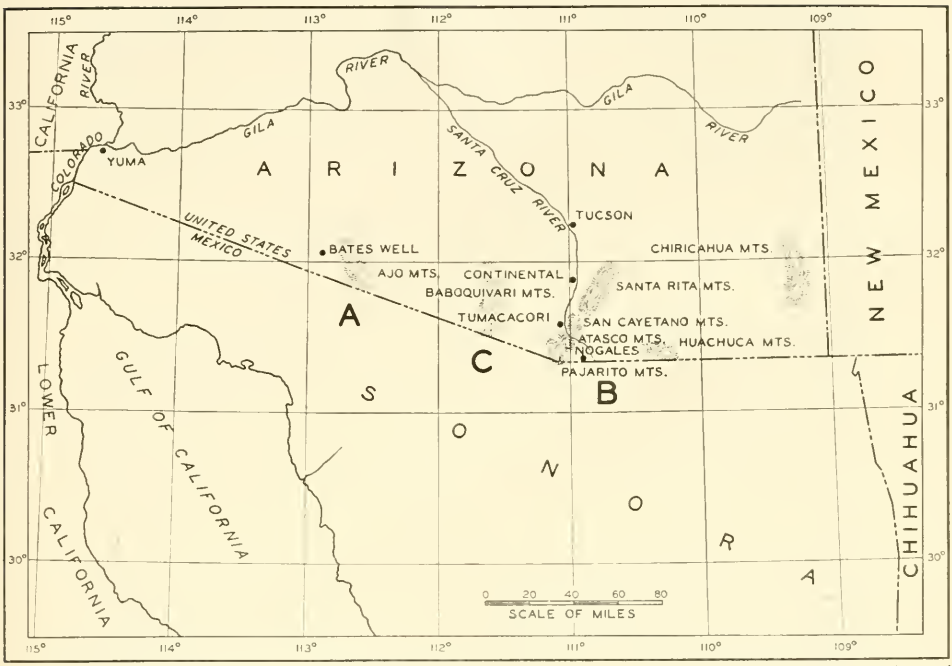
In June, 1932, I again returned to southern Arizona and in company with Dr. Walter P. Taylor of the Biological Survey and Mr. David Gorsuch of the University of Arizona worked from Peña Blanca Spring in the Pajaritos west around the northern end of the Baboquivaris to Fresnal on the west side of that range, and thence west to Ajo and south to Bates Well. One side excursion was made to the border village of San Miguel on the west side of the Baboquivaris. R. T. Moore of Pasadena who contributed, in part, the necessary field expenses, accompanied us as far as Fresnal. After three days at Bates Well, Gorsuch and I returned (on June 25) to the Santa Ritas, where I spent several days in Stone Cabin and Madera Cañons before returning to Pasadena.

Briefly, the discrepancy between Mearns' (1907) concept of the "Elevated Central" and "Western Desert" tracts, and Swarth's (1929)

limits of his "Eastern Plains" and "Western Desert" areas involves the not inconsiderable distance of some 120 miles! Mearns considered the longitude of the Ajo Mountains (specifically, Monument 163 in the Sonoyta River Valley) to be the dividing line; Swarth decided on the Santa Rita Mountains. Such opposition between two observers as experienced as Mearns and Swarth was incomprehensible to me until personal investigation showed each to have basis for his belief insofar as the territory explored by him was concerned. Mearns, except for side trips to Tucson and Fort Lowell, worked close to the border and was never more than a few miles north of that line; Swarth had never been along the border west of Nogales.

Our own investigations showed Mearns' account of the border west of Nogales to be an excellent picture of actual conditions; in other words, from Nogales to the Baboquivaris (see Plates 17 and 18) there is exceedingly close resemblance in most particulars to the Sonoran zones of his "Elevated Central Tract" and to Swarth's "Eastern Plains Area." Topographically the country is, in places, more broken than east of the Santa Ritas, but floral and ecological conditions are practically the same. On the higher levels are scattered stands of blue oaks, with sycamores and other characteristic Upper Sonoran growth in the cañons. On levels below the oak belt and at intervals between oak areas are grass covered plains, more or less rolling and less level than to the east, but virtually the same type of country nevertheless. These grass areas, particularly those on fairly level ground, frequently support a thin growth of mesquites—small trees spaced well apart and so regularly that, as Swarth has so graphically described them, one is forcibly reminded of a "young peach orchard."

Along the border west of the Baboquivaris is a type of desert which I have not encountered elsewhere (save very locally) in Arizona. In most places the terrain consists of broad, level, grass plains which are varied along the usually dry water courses with dense thickets of large mesquite. At occasional points one encounters a more typical Colorado Desert topography and flora. Separating these plain-like valleys are stony ridges or low mountains which support a more familiar desert vegetation—giant and other cactus, greasewood, and low thorny scrub. This alternation of valleys and ridges extends west nearly to Ajo, at about the point where Mearns terminated his "Elevated Central Tract." Presumably, Mearns supposed that conditions similar to those in the immediate vicinity of the border persisted to the northward, and since the



Map 1. Southern border of Arizona and surrounding territory. A—Western boundary of the "Elevated Central Tract" as determined by Mearns. Two subspecies of Lower Sonoran Zone birds (*Pipilo fuscus mesoleucus* and *Phalaenoptilus nuttallii nuttallii*) here reach their western limits. B—Western boundary of the "Eastern Plains Area" as determined by Swarth. This point marks the western limits of two Lower Sonoran subspecies (*Toxostoma curvirostre curvirostre* and *Agelaius phoeniceus nevadensis*). C—Here, at the Baboquivari Mountains, terminate, westwardly, the ranges of seven species and subspecies characteristic of the Lower Sonoran Zone of the "Apache Faunal Area" and also many of that Area's Upper Sonoran forms. The seven Lower Sonoran birds are: *Colinus virginianus ridgwayi* (formerly), *Callipepla squamata pallida, Otocoris alpestris adusta, Corvus cryptoleucus, Geothlypis trichas chryseola, Sturnella magna lilianae,* and *Spizella carpalis carpalis.*

general features of this part of the border more closely resemble the Lower Sonoran Zone of the "Elevated Central Tract" than they do the excessively barren desert to the westward one surely cannot criticize him for linking it with the former. Concerning the faunal affinities of this stretch from the Baboquivaris to Ajo, I cannot be certain at this time. At least two of the Lower Sonoran subspecies which are characteristic of southeastern Arizona range over this stretch, and possibly there are others. On the other hand "Western Desert" birds appear to be vastly in the majority. The faunal affinities, as a whole, are more probably with the Colorado Desert than otherwise. I have not been along the border between Ajo and Yuma, save for a very short distance east of Yuma.

Mearns' "Western Desert Tract" and Swarth's "Western Desert

Area" are, in effect, practically synonymous (although not entirely so) with Grinnell's (1928) "Colorado Desert Differentiation Area." Mearns' "Elevated Central Tract" and Swarth's "Eastern Plains Area," on the other hand, are only in part comparable. Mearns' concept (properly, I believe) included the Sonoran and Boreal Zones; Swarth, specifically, considered in his studies only the Lower Sonoran. There is every reason to believe, in fact intensive studies of the geographic behavior of the birds of Sonora and Chihuahua make it almost certain, that southeastern Arizona is, on the basis of its Lower Sonoran, Upper Sonoran, and Boreal Zone birds, the northwestern portion of a large and well characterized area of differentiation which has as its geographical hub the mountain mass of the northern Sierra Madre which lies north of the east-west course of the Yaqui River. This may appropriately be designated as the *Apache Faunal Area.*

In the following pages I have confined observations to "new" data, that is such as change or modify current ideas of faunal areas, range extensions, or systematic status. Maps have been added when thought necessary or desirable in order to make more graphic the problems involved. Carefully avoided have been data which would simply be repetition of the work of former observers. Needless to say, the Arizona-Sonora border is still a relatively unexplored territory and I have no illusions as to the finality of any ideas or statements expressed. Future field work may well, and probably will, modify any or all of them.

Accipiter atricapillus striatulus (Ridgway)

The American Goshawk seems not to have been previously recorded from the Santa Ritas. On May 1, 1931, and on two subsequent occasions Dr. Loye Miller and I saw an adult in the pines at about 7500 feet altitude in Madera Cañon. Considering the date and the actions of this bird, which obviously resented our presence, it seems reasonable to suppose the probability of a nest somewhere nearby.

Specific records of the goshawk in extreme southern Arizona are still sufficiently rare to make permissible the recording of some occurrences in the Chiricahuas. The Dickey collection contains an adult male taken by H. H. Kimball on July 10, 1918, at Paradise, an adult female taken by Kimball at an unknown locality (in the Chiricahuas) on December 5, 1918, and a juvenal female collected by Frank Hand in Pinery Cañon on February 9, 1928. None of these three individuals can be assigned to the eastern race, for they all possess the dark dorsal coloration and, in the juvenile, the broad blackish-brown ventral streaking, which characterize the race *striatulus* as now understood. In fact they are slightly but appreciably darker than average goshawks from the northwest coast. In the British Museum is a similarly dark-colored adult taken by W. Lloyd at Yecora in the

high mountains of east central Sonora on April 13, 1888, and also two nearly full-grown juveniles (which may well have been collected directly from the nest) taken by W. B. Richardson in the Sierra Nayarit, Jalisco. This last record is apparently far south of any previously known breeding station.

There is the possibility that a definable race, distinct from *striatulus,* exists in the Mexican highlands and that its range includes the mountains of extreme southern Arizona. The appearance of the Jalisco juveniles, which are the darkest I have ever seen, is further indication that such is the case.

I most emphatically follow Peters (1931), and most European ornithologists, in considering *Astur* congeneric with *Accipiter.*

Accipiter cooperii mexicanus Swainson

Several pairs of the Western Cooper's Hawk were found in the Baboquivaris, a point which marks the extreme western limit of territory suitable for breeding purposes. An adult male was collected with a set of four eggs in a small cañon at 5500 feet altitude at the east base of Baboquivari Peak on May 27, 1931. Other breeding pairs were noted at intervals in the oak regions along the border between Nogales and the Baboquivaris and, in common with former observers, we found several breeding pairs in the Santa Ritas.

Buteo albonotatus Kaup

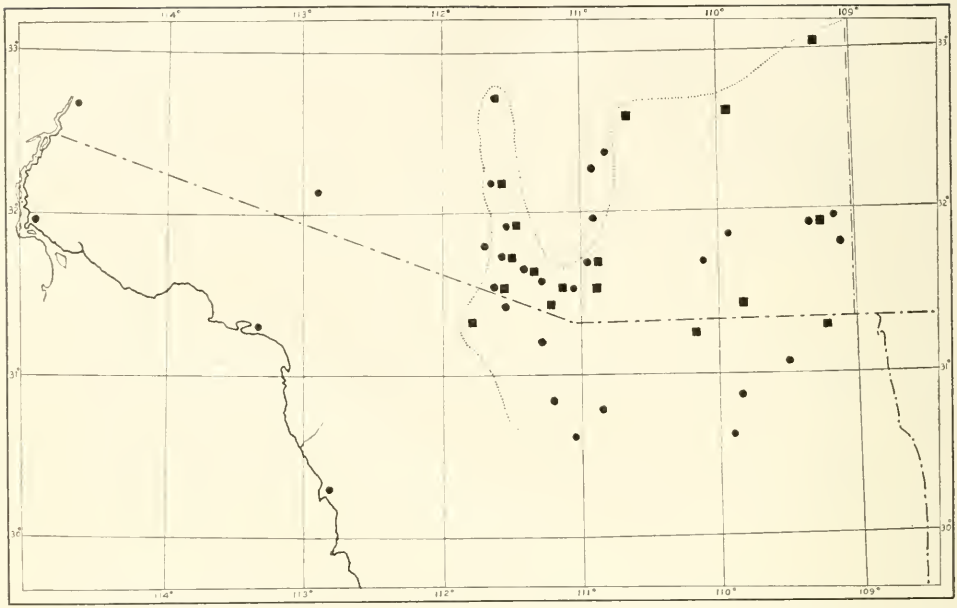
A single adult Zone-tailed Hawk was seen on the ground beside the road near Arivaca on May 23, 1931. In the Baboquivaris, a pair was found nesting in the oaks in Thomas Cañon on the east side of the range. One parent (the female) was collected on May 24; the other, the male, who was then incubating the set of two eggs, on the 25th.

Save for the several records from the lower Colorado River, some of which are dubious and more probably pertain to Harris's Hawk, I believe the specimens taken in the Baboquivaris to be the westernmost known occurrences of the Zone-tailed Hawk in southern Arizona. Since this hawk is distinctly partial to oak and sycamore timber (chiefly Upper Sonoran Zone) during the breeding season, the Baboquivaris in this, as in many other cases, probably constitute the western range limit along the border.

Callipepla squamata pallida Brewster

We found the Scaled Quail to range west along the border foothills and uplands to the east slope of the Baboquivari Mountains. In this territory we found it common, although usually outnumbered by Gambel's Quail. We noted it almost continuously along grassy, broken ground north almost to Picacho, but at no point west of the Baboquivaris.

While I agree with Swarth that the Scaled Quail (or in a more properly restricted sense the subspecies *pallida*) is one of the characteristic birds of the "Eastern Plains" fauna, I cannot for a moment subscribe to a belief that Gambel's Quail is an indicator of his "Western Desert Area." Gambel's Quail is common, locally, clear across the "Eastern Plains" to the Chiricahua Mountains at least, where it is abundant. In fact in certain washes along the western foothills of that range I found it, in 1914 and 1915, to outnumber the Scaled Quail. Similarly,



Map 2. Distribution of two species of quail, *Callipepla squamata pallida* (squares), and *Lophortyx gambelii gambelii* (dots) in southern Arizona and northern Sonora. The broken line which encloses the range of *pallida* also indicates in a general way the western and northern section of the "Apache Faunal Area."

south of the boundary, the Scaled Quail is an excellent faunal indicator, but *gambelii* ranges east across the state of Sonora to the foothills of the Sierra Madre.

Cyrtonyx montezumae mearnsi Nelson

In common with many other Upper Sonoran birds, Mearn's Quail ranges west of the Baboquivaris (both slopes; see Bruner, 1926), which mountains necessarily mark the extreme western limit of the species along the border. We also found it to be fairly common in the Atasco Mountains and about Peña Blanca Spring in the Pajaritos.

Otus asio cineraceus (Ridgway)

The distribution of the common screech owls in extreme southern Arizona west of the Santa Ritas cannot be finally outlined until more specimens have been collected from critical localities. One thing is certain, however, and that is that *cineraceus* occurs west along the border considerably beyond the range now accorded it. Dr. Miller and Berry Campbell (1934) took several specimens (examined by me) at Peña Blanca Spring, Pajarito Mountains, in June, August, and September. I found a fully grown juvenile dead in the road between Oro Blanco and Arivaca on June 19, and Dr. Taylor collected a juvenile and an adult,

(also examined in the present connection), at Arivaca (a Lower Sonoran locality, incidentally), on June 20, 1932. In the Baboquivaris a screech owl, probably of this subspecies, was heard but not collected.

The subspecies *gilmani* has been recorded from the Santa Ritas (Bailey, 1923), but Dr. Oberholser informs me that the specimen which was the basis of the record cannot now be found in the Biological Survey collection. In view of the fact that Swarth (1929) took a family of *cineraceus* there, the *gilmani* record is decidedly open to question.

In considering the western limits of the range of *cineraceus,* it has been advisable to re-examine the type series of *Otus asio cardonensis* Huey from Lower California, since *cardonensis* has been synonymized with *cineraceus* by Grinnell (1928). Entirely aside from the incongruity of such a "split" range—that is two colonies of *cineraceus* separated from each other by *gilmani*—I can see no valid reason for not recognizing *cardonensis* on its own character merits. Although *cardonensis* is very close to *cineraceus* and has the same gray cast of plumage (that is with almost complete absence of brown tones), *cardonensis* is definitely darker, and is more leaden (less ashy) than *cineraceus*, both above and below.

Otus trichopsis trichopsis (Wagler)

The occurrence of this rare screech owl in the mountains of south-central Arizona was to be expected, but that it should prove to be common in a locality which had prevoiusly been worked extensively was surprising.

About 9 o'clock on the evening of June 4, 1931, the notes of a small owl were heard in the sycamore and oak timber along the stream which runs past the resort in Madera Cañon in the Santa Ritas. These notes, while unmistakably "screech-owl" in character, were very different in cadence from those of any member of the *asio* group covered by my experience. They consisted of a repetition of three short notes, a slight pause, and a fourth, terminal note, "- - - -, - - - -, - - - -, - - - -." A whistled imitation soon decoyed the caller, which proved to be a Spotted Screech Owl, within range. On June 5, a night trip of several hours' duration pretty well prospected Madera Cañon between the resort at 5500 feet altitude and Littleshot Cabin at 7000 feet. Among other nocturnal rarities encountered, Spotted Screech Owls were located, by the unmistakable call notes, at five different points and by calling the birds from a central location I had four individuals close to me at one time. On this occasion a mated pair was collected. Two nights later, two pairs were located in the south fork of the cañon at altitudes of 6000 and 6500 feet respectively. One of these pairs was collected in an oak grove near the stream.

At no time were *asio* call notes heard in Madera Cañon, and I was tempted to conclude that *trichopsis* and *asio* were not likely to be found in the immediate vicinity of each other. However, I subsequently learned that Dr. Miller and his party took several examples of each species at Peña Blanca Spring in the Pajaritos.

Stomachs of the pair collected on June 7 were submitted to the Biological Survey and their report is herewith appended.

Male—Condition of stomach: full
Percentage on animal matter, 100; of vegetable, —
Contents: 1 *Diplotaxis* sp. = 2%; 13 *Noctuidae* larvae = 87%; 1 adult *Lepidoptera* = 2%; 2 *Formicidae* = trace; 1 Spider = 7%; fur of a small rodent = 2%.

Female—Condition of stomach: nearly full
Percentage of animal matter, 100; of vegetable,—
Contents: 1 *Acrididae* = 5%; 6 *Gryllus assimilis* = 60%; 2 *Noctuidae* larvae = 25%; 1 other Lepidopterous larva = trace; 1 adult *Noctuidae* = 5%; 1 spider = trace; 1 scorpion = 5%.

Otus flammeolus (Kaup)

Flammulated Screech Owls were found only in the Santa Ritas, from which range they have not previously been reported. At Littleshot Cabin, in the mixed oaks and pines at 7000 feet, a male was collected at dusk on June 6, 1931, as he was flying about through the trees. This bird was not at all shy and decoyed readily to a squeak. Three days later, on June 9, I noticed a feather clinging to the entrance of an old flicker hole some ten feet from the ground in a dead pine stub a quarter of a mile above the spot where the male had been shot on the 6th. The stub was pushed over without much difficulty, and the hole was found to contain a female Flammulated Screech Owl and two newly-hatched young. This nest probably did not belong to the male taken on the 6th, for another Flammulated Screech Owl was seen to visit the site on several occasions during the night after the female and young had been collected.

I could perceive no definite eye shine from either of the two individuals seen at night, though the visitor to the nest site occasionally gave out a greenish white glint as the bird was viewed in profile. No notes, which could be certainly attributed to this species, were heard, although on one occasion a small owl, which I concluded because of its size to be a Flammulated Screech Owl, was heard calling in an oak grove at 6000 feet in Madera Cañon. The call notes, which were given persistently, might be described as a poor-will call reversed—that is to say with the higher of the two notes given first. This bird was so shy that it flew rapidly from tree to tree in order to avoid the beam of the flashlight, and never remained stationary long enough to be collected, even by a snap shot.

The two newly-hatched young collected on June 9, 1931, are thickly covered with snowy white down, with, in life, the bills and feet flesh color. The irides, both of adults and young, were very dark, nearly blackish, brown—very different from the yellow irides of the common and spotted screech owls. In plumage, neither adult is in an extreme color phase; the female, though, is definitely more rufescent than the male.

I am indebted to the Bureau of Biological Survey for the following stomach analyses of the two adults collected.

Male—Condition of stomach: full
Percentage of animal matter, 100; of vegetable, —
Contents: 3 *Diplotaxis* sp. = 25%; 4 *Noctuidae* larvae = 35%; 2 other *Noctuidae* larvae = 5%; 6 adult *Melipotis* sp., probably *indomita*, = 35%.

Female—Condition of stomach: full
Percentage of animal matter, 100; of vegetable, —
Contents: 1 *Gryllus assimilis*=trace; 5 *Diplotaxis* sp.=35%;
11 *Noctuidae* larvae=65%.

Glaucidium minutissimum gnoma Wagler

Three specimens of the Pigmy Owl were collected, a breeding pair in the Atasco Mountains and a male in the Santa Ritas. In view of the rarity of the species, and particularly this subspecies which is here recorded for the first time from the United States, the circumstances of their capture seem worth recording.

The breeding pair was encountered on May 19, 1931, as Dr. Burt and I were coming down through a grove of blue oaks at 4500 feet in Piskiorski Cañon. As we passed under a small oak, a Pigmy Owl flew out and perched at the very tip of another oak nearby. It proved to be an adult male. Investigation of the tree from which he had flown showed three old nest holes of the Arizona Woodpecker in the main trunk, at heights of from 12 to 15 feet above the ground. Since the holes were drilled in the hard live wood they could not be opened at the time, but I returned next day and chopped out the most favorable looking one. The female refused to leave the hole during chopping operations, but flew out when I descended for a moment to the ground. She, like the male, flew to the tip of a nearby oak. There were four eggs in the nest, two of them fairly well incubated, the other two claw-marked and seemingly infertile.

The male taken near Littleshot Cabin in the Santa Ritas on June 1, 1931, was noticed, quite by accident, perched at the tip of a small dead sycamore and in the full glare of the mid-day sun. Just before he was shot he was attacked furiously by a female Rivoli Hummingbird.

The only other Pigmy Owls that I have been able to examine from extreme southern Arizona are a male from the Huachuca Mountains (32378 Museum of Vertebrate Zoology) and a male from the Santa Ritas (406 San Diego Soc. Nat. Hist.).

For over ten years I have been keeping notes and measurements of Pigmy Owls whenever opportunity arose. The total examined has been in excess of 200 specimens and over 100 have been assembled at one time. The conclusions reached differ in several respects with some previously published opinions, not only as to the systematic status of birds from certain regions but as to the ranges currently accorded several subspecies.

In the first place, it is very evident that the matter of color phases has not received anywhere near the consideration it deserves. Secondly, size and proportions are of much more value than has been realized. Among recent writers Dr. L. B. Bishop (1931) has been practically alone in his contention that the race *pinicola* of Nelson is only the extreme gray phase of *californicum*. With this belief I am in agreement. However, I cannot subscribe to placing the Pigmy Owls of the northern Rocky Mountains with *californicum*. Compared with northwest coast examples of *grinnelli*, the interior birds unquestionably average paler or grayer, but certain interior birds are just as red or as richly colored as coastal *grinnelli*. The appended table of measurements shows the size agreement between coastal and interior Pigmy Owls and there remains only an incomplete phase

segregation by which to distinguish series from the two areas. I suggest to anyone interested a study of the geographic phase behavior of the closely related *Glaucidium brasilianum ridgwayi* as illuminating in the present connection.

To return to the Pigmy Owls of southern Arizona, I must confess at the outset to having misled Dr. Bishop on the subspecific status of the Atasco Mountains pair, for at that time I had not made the critical comparisons which subsequently proved to be necessary. Briefly, the southern Arizona specimens differ from "*pinicola*" [=*californicum*] in their decidedly smaller size, more conspicuously spotted upper parts and slightly darker (phase for phase) coloration. The four males are all in the gray phase, the female in the brown or "mongrel" phase. I cannot distinguish them in any way from *gnoma* of the Mexican highlands and the range of *gnoma* should be corrected to read "north to the Huachuca, Santa Rita, and Atasco Mountains in extreme southern Arizona."

Glaucidium minutissimum[1] Males

		Wing		Tail		
4	*gnoma*	84-91	(88.0)	58-62	(60.4)	Mexico
4	*gnoma*	86-90	(88.5)	60-61	(61.0)	Arizona
6	*californicum*	91-98	(94.5)	64-69	(67.2)	California Sierras
4	*californicum*	90-100	(94.0)	65-68	(67.5)	New Mexico
1	*grinnelli*		(88.0)		(67.0)	Wrangle, Alaska
6	*grinnelli*	85-92	(89.2)	62-67	(65.3)	Puget Sound Region
8	*grinnelli*	87-91	(89.7)	61-65	(64.1)	Western Oregon
10	*grinnelli*	88-92	(90.5)	60-67	(63.3)	N. W. California
27	*grinnelli*	87-92	(90.0)	62-67	(65.4)	Interior Brit. Columbia and northern Idaho
3	*swarthi*	84-89	(86.3)	61-63	(61.7)	Vancouver Island

Micropallas whitneyi whitneyi (Cooper)

Perhaps the most noticeable of night noises in the cottonwood groves along the Santa Cruz River in the vicinity of Tumacacori Mission, in early May, 1931, were the familiar call notes of the Elf Owl. This point is some 14 miles from the nearest giant cactus (a small grove near Continental), and nearly 40 miles from the extensive groves to the west of Tucson. On the night of May 14, I had no trouble in locating, with the aid of a flashlight, two pairs within a hundred yards of camp, nor in collecting three specimens in almost as few minutes. I saw at

[1] Mr. Ludlow Griscom (1931) has recently reviewed the Central and South American races. He is unquestionably correct in his contention that *gnoma* and *minutissimum* are conspecific and that the two supposed species blend through *griseiceps* and *cobanense*. A critical examination of the material in the British Museum, including the types of both races, shows that the Guatemalan lowland race *griseiceps* (13 specimens) is distinct from *cobanense* (5 specimens) by reason of the definitely shorter tail and the lesser number of tail bands. Incidentally *griseiceps does* have a red phase which is (in the single instance known to me) indistinguishable in color from *cobanense*. In such rare cases the measurements are, of course, diagnostic. Measurements of these two interesting races are appended.

MALES (Some *griseiceps* not Marked on Tags as to Sex)

	Wing	*Tail*	*Tail bands (excluding tip)*
3 *cobanense*	67-88	59-62	6 to 7
13 *griseiceps*	84-90	48-58	3 to 6

least a dozen birds within half a mile and could have taken all of them had it been desirable to do so. They were always in pairs, even though the breeding season was at its height, and for the most part they were located first by call notes and then observed with a flashlight. By far the greater number were in the medium height cottonwoods, perched or flying about in the branches below the crown foliage. Two were seen in a pile of drift-wood in the dry stream bed, and one in a mesquite thicket. The oviduct of the single female collected contained an egg ready to be laid. One pair was seen repeatedly to enter a small natural cavity, some thirty feet above the ground, in the trunk of a half-dead cottonwood. In June, 1932, our party found Elf Owls to be not uncommon at Peña Blanca Spring, Pajarito Mountains, in the live oak association of the Upper Sonoran Zone at about 4000 feet. One pair, accompanied by grown young, was found within a hundred yards of the spring, and enough additional birds were heard to convince us that several pairs were in the vicinity. This locality was one in which spotted and Mexican screech owls, poor-wills, acorn woodpeckers and other characteristic Upper Sonoran species were present—an unexpected place, surely, in which to find the supposedly cactus-restricted Elf Owl! Campbell (1934) has previously recorded Elf Owls from this same locality.

A single Elf Owl was found half hidden in a mistletoe clump in a mesquite thicket at Bates Well on June 22, 1932. There was no giant cactus in the immediate vicinity of this spot, but scattered plants were noted a half mile or so away. This bird is now in the collection of the University of Arizona.

Strix occidentalis lucida (Nelson)

The barking calls of Spotted Owls were frequently heard at night in the Santa Ritas, invariably between altitudes of 6000 and 8000 feet. At Littleshot Cabin, shortly before dusk on June 8, 1931, a Spotted Owl, subsequently found to be a female, suddenly appeared on the roots of a fallen tree, ten feet from the spot where I sat watching a whip-poor-will catch low-flying insects along the course of a small stream. This owl was not in the least disturbed by my presence, but obviously was intensely curious; indeed I believe it came down with the sole purpose of a close range inspection. At about 9 P. M. another Spotted Owl was heard barking from higher up the cañon. When I answered, it came immediately and perched in a pine tree not twenty feet distant. Like the first bird it was perfectly fearless and I had excellent opportunity to test it for eye shine. Though it was looking straight at me for several minutes I could get no reflection of any sort, the eyes appearing perfectly black at all times. This bird, a male, was very probably the mate of the female taken earlier in the evening.

In 1932 another pair of Spotted Owls were found to have come into the territory opened up by the taking of the pair in 1931. Both birds were seen several times, and still more frequently were heard at night as they barked to each other from opposite sides of the cañon. These 1932 birds were not nearly so tame as the first pair, but usually could be decoyed to reasonably close distances by an imitation of their calls. This pair was not molested.

A Spotted Owl was seen, at dusk, to fly out of a grove of oaks near a spring at about 7000 feet in Stone Cabin Cañon on June 25, 1932. Although this bird exchanged barks with me for more than an hour, it refused to come closer than

a hundred yards. It was evidently disturbed by the flashlight and would promptly shift location at every attempt to find it with this means.

Bailey (1923) and various other observers have also found Spotted Owls in Stone Cabin and Madera Cañons. The species is evidently fairly common in the Santa Ritas.

Asio otus wilsonianus (Lesson)

According to Swarth (1929) the Long-eared Owl has been detected but once as a breeding bird in Arizona, the record being that of a young bird taken at 5000 feet altitude in Stone Cabin Cañon on the west side of the Santa Ritas. It was of interest, therefore, to find a family of these owls in the mesquite (Lower Sonoran Zone) along the dry stream bed at Bates Well. The young were nearly full grown, but partly in juvenal plumage. One specimen, a juvenal male, was collected on June 23, 1932.

Caprimulgus vociferus arizonae (Brewster)

The vertical range of Stephens's Whip-poor-will is not limited to the higher mountains. Above 6000 feet in the Santa Ritas many birds were heard on every occasion that we stayed out after dark, but I also heard a whip-poor-will several times at 5000 feet in the Atascos and Dr. Miller collected a specimen at Peña Blanca Spring, Pajarito Mountains, in June, 1931. These last two localities are well down in the Upper Sonoran Zone.

I took, all told, six specimens of this common, though seldom collected, whip-poor-will and saw or heard several times that number. In the Santa Ritas they showed a decided preference for groves of oaks and sycamores in the cañon bottoms, and nearly all of those which were found at night were feeding in the immediate vicinity of running water. A pair to the mile seemed to be normal in most cañons which contained water and it was obvious that each pair had its own territory.

Though males, and sometimes, before eggs were laid, mated pairs, were invariably found in the cañon beds, the two nests discovered were on hillsides at least a quarter of a mile from water. On the night of June 6, 1931, I caught the red eye-shine of a whip-poor-will some distance away (estimated by daylight at 150 yards) and across a steep-banked cañon. With no expectation of collecting anything I followed the trail to a point where I estimated the shine to have been, but could locate nothing and supposed that the bird had gone. On my return to the original spot the eye was seen in the same location as before, and this time, after a little search, I found a female sitting under the protection of a fallen spray of leafless twigs which lay on a steep bank beside the trail. Three of us had passed within five or six feet of this sitting bird on two occasions the day before. The sitting bird made no effort to escape and was picked up by hand. There was one nearly fresh egg in the shallow depression in the gravelly soil which served as a nest, and stuck to the ventral plumage of the incubating female were several small pieces of shell, showing that another egg had been laid and somehow broken. This single egg was by no means immaculate white, but was clouded and mottled with brown and lilac, mostly in the nature of semi-concealed shell markings. It was similar to but very much less highly colored than eggs of the eastern *vociferus*, however.

A second nest found on the night of June 27, 1932, within two feet of the same trail was, like the first, under a slight canopy of dead oak twigs. This nest contained one pure white egg and a newly hatched chick clothed with a very respectable covering of down—in color between "cinnamon" and "orange-cinnamon" of Ridgway.

A, to me, surprising circumstance, was the marked erectability of the feathers above the eyes. Both of the sitting females carried these tufts constantly erect the entire time they were under observation. A male seen from directly in front alternately raised and flattened them. On one previous occasion, when night hunting in El Salvador, I had observed the eastern subspecies (*vociferus*) to have markedly erectile tufts; in fact until I picked the bird up I was certain that I had shot some small "eared" owl. About 45° from the horizontal was the maximum elevation, though when viewed from directly in front the tufts appear nearly vertical.

Phalaenoptilus nuttallii nuttallii (Audubon)

Poor-wills were heard at night chiefly in the oak association of the Upper Sonoran Zone but we also found them to be common on the Lower Sonoran desert. Specimens were taken in the Atasco Mountains, Pajarito Mountains and at Bates Well. This last locality is interesting as indicating the approximate area of intergradation between *nuttallii* and *hueyi* of the lower Colorado River Valley. The series of 4 birds from Bates Well is certainly referable only to *nuttallii,* but an approach to *hueyi* is seen in the slightly browner and paler coloration. These specimens were taken on June 22 and 23, 1932, a date which precludes the possibility of their being migrants. The two males were in breeding condition; the two females were evidently incubating. All were collected in an arrowweed-mesquite association along the borders of the dry stream bed. Conditions, both as to habitat and temperatures, closely approximated those found along the Lower Colorado River Valley, beyond the confines of which *hueyi* has not been detected.

Previous to this time I had anticipated that *nuttallii* would be found to be confined, during the breeding season, to the Upper Sonoran Zone and that *hueyi* would be found to be the race of the Lower Sonoran deserts. That the distribution of the two races is *not* dependent on zonal considerations is obvious by reason of the presence of *nuttallii* at Bates Well.

Selasphorus rufus (Gmelin)

One specimen was taken at 4500 feet Stone Cabin Cañon in the Santa Ritas on April 27, 1931. I believe the Rufous Hummingbird has not been previously detected in these mountains during the spring migration.

Trogon elegans canescens van Rossem

Regardless of its status in former years, this trogon may now be counted a fairly common summer visitant in the Santa Ritas. Possibly it has always been more numerous than was supposed, for one of the rangers, who has been stationed for many years in the Santa Ritas, knew the bird well and told me of having seen as many as five or six feeding together at a single patch of manzanita. At any rate there were several pairs in Madera Cañon in the summers of 1931 and 1932.

The loud, hoarse, "kóa-kóa-kóa" call of a male trogon was first heard in the pines at the head of Madera Cañon on May 1, 1931, but he was moving continually and we never were able to catch sight of him. On May 30 of the same year we occasionally saw, and more frequently heard, at least two pairs in the right hand (south) fork of the cañon about two miles above the resort, and at altitudes of between 6000 and 6500 feet. The association in which they were noted was the oak-sycamore growth near the juncture of Upper Sonoran and Transition. Two more males (both of which presumably had mates) were heard in the left (north) fork—one at 7000, the other at 8000 feet altitude. These altitudes are in the pine-oak association in the Transition Zone.

On June 8, 1931, while tramping through a bed of fallen sycamore leaves at 6000 feet, I found a female trogon flopping about but unable to rise from the ground. Dissection showed that she had been shot in the body with what appeared to be an air gun pellet. The spot where she was found was a frequently occupied camp site, and the assumption is that she had been wounded by one of the many campers present the previous week-end. In 1932, trogons were still more plentiful. On June 27, Mr. Gorsuch and I saw or heard eight birds between the forks of the cañon, at 6000 feet, and Littleshot Cabin at 7000. On that date a fully adult male was collected by Mr. Gorsuch for the museum at the University of Arizona. On June 28, a very young trogon, about two-thirds grown and evidently just out of the nest, was shot, quite unintentionally, in a patch of oaks at 6000 feet. It was perched about two feet from the ground in fairly thick undergrowth and was mistaken for a juvenile robin. This specimen has been donated to the University of Arizona, for trogons are, properly, on the list of species the collecting of which is prohibited.

Dryobates villosus icastus Oberholser

Hairy Woodpeckers were not uncommon in the higher parts of the Transition Zone in the Santa Ritas, where one specimen was collected at 8500 feet altitude on the east slope of Mt. Wrightson on June 5, 1931. The record is apparently the first for the Santa Ritas, though the occurrence of the species was to be expected.

Dryobates arizonae arizonae (Hargitt)

Like that of many other Upper Sonoran species, the range of the Arizona Woodpecker extends west (Bruner, 1926) to the Baboquivaris. We found it to be common in those mountains (specimen taken in Thomas Cañon at 5500 feet altitude) and also in the oak association of the Atascos and Pajaritos.

Myiarchus tyrannulus magister Ridgway

But one specimen of the Arizona Crested Flycatcher was taken and this is recorded only because of the nesting of the species at a point some ten or eleven miles from the nearest giant cactus.

Though Swarth (1929) noted the first arrivals on May 15, the season of 1931 must have been somewhat advanced, for two pairs were seen in the cottonwoods along the dry bed of the Santa Cruz River two miles south of Tumacacori Mission on May 12. Both of these pairs were engaged in carrying nesting

material into natural cavities in tall cottonwoods, and it must be supposed that they had arrived in the locality some days at least prior to that date. The male of one of these pairs was collected on the 13th.

Myiarchus tuberculifer olivascens Ridgway

In common with many other birds whose habitat is mainly in the Upper Sonoran Zone, the Olivaceous Flycatcher extends west through the oak covered hills along the international boundary to the Baboquivari Mountains. We found the species to be common in the oaks of the Atascos, Pajaritos and Baboquivaris, and also found it nesting, not uncommonly, in the cottonwoods at Tumacacori. This last locality has an altitude of 3300 feet, and is well within the Lower Sonoran life zone. At no other point in Arizona, so far as I am aware, have the Olivaceous Flycatcher, Ash-throated Flycatcher, and the Arizona Crested Flycatcher been found nesting in the same locality and environment, although Campbell (1934) records all three species at Peña Blanca Spring in the Pajaritos "before July 15," a date which indicates that they were breeding birds.

In southern Sonora and southward the Olivaceous Flycatcher is widely distributed zonally, and I believe that its usual close adherence to the Upper Sonoran in northern Sonora and Arizona is because of preference for a woodland habitat and not because of any intolerance for Lower Sonoran temperatures.

Specimens were collected in the Santa Ritas, Atascos, Baboquivaris (Thomas Cañon, May 27, breeding), and Tumacacori (nesting pair taken May 12).

Empidonax difficilis difficilis Baird

Four breeding specimens of the Western Flycatcher were collected in Madera Cañon, Santa Rita Mountains, at altitudes varying from 6000 to 7000 feet. These are all of the large, dull-colored (as yet unnamed) form which breeds in the southern Rocky Mountains north to Wyoming and Montana and west to the Warner Mts., Oregon. In measurements the males from the interior average about 70 mm. in wing length and 60 in tail length, as opposed to about 64 and 55 mm. for far western birds from Alaska south, coastwise, to southern California. The coloration of the interior birds is grayer and duller when specimens in equal stages of wear are compared.

A migratory specimen of typical *difficilis* was collected in the Atasco Mountains on May 19, 1931.

Camptostoma imberbe ridgwayi (Brewster)

The Beardless Flycatcher is not new to the territory of this paper, indeed the Santa Cruz River Valley is evidently the center of its range in Arizona. But since it has been supposed to be rare, there is justification for placing our observations on record.

I believe this species to be common in southern Arizona, and that the chief reason why it has not been detected more often is its close resemblance in color, size, and call notes to the Verdin.

I first heard the "verdin" notes of this species at Continental on April 24, 1931, and caught occasional flashes of a bird in a dense patch of mesquite and second growth cottonwoods along the nearly dry stream bed. On the 26th, Dr.

Miller and I went back to the same spot and succeeded in taking both members of a pair which was nearly ready to breed. We next met the Beardless Flycatcher in a grove of oaks, alders, and sycamores near the mouth of Madera Cañon in the Santa Ritas, at an altitude of about 4000 feet and just at the juncture of Lower and Upper Sonoran Zones. A pair of these birds was obviously much interested in one section of a sycamore grove but, though we watched them for several hours, we could find no nest. Both birds kept well up in the foliage at from twenty to forty feet from the ground, though one made frequent flights to a small clump of young mesquites on the hillside nearby. This pair was certainly breeding, for the condition of the female showed her to be incubating and she had but recently finished laying. At Tumacacori we found Beardless Flycatchers to be common in the groves of cottonwoods and willows along the dry river bed. I estimated the population to average a pair to every quarter-mile for at least two miles either way from our camp. However, pairs were by no means regularly spaced

One might easily have missed seeing any or all of these birds, for they were decidedly partial to perches just under the crown foliage of the cottonwoods at heights of from twenty to fifty feet. Were it not for the tell-tale, verdin-like piping, a search in such an environment would not be likely to produce results, for the diminutive size of the birds, their inconspicuous coloring, and rather sedentary habits combine to make them exceedingly difficult to detect, even after their general location has been ascertained. I found that sitting quietly and waiting for a flycatcher to become concerned about my continued presence was a much better method of locating pairs than to search at random. Every grove of good-sized cottonwoods contained at least one pair and sooner or later, if one kept quiet, the male would begin to sound his sharp alarm notes and to flit nervously about the grove. As often as not his mate would join him for a few minutes and then disappear.

A nest was found on May 13. It was about twenty-five feet above the ground and was tucked into the pendent stems of a clump of mistletoe which grew at the tip of a cottonwood branch. Certain that a nest was near at hand, I spent two hours in trying to follow the more elusive member of the pair and finally saw her disappear into one of several clumps of mistletoe. No nest was visible from the ground, but by climbing an adjacent tree I could see it plainly enough. In the absence of a sufficiently long rope the site was inaccessible, and I finally shot off the branch in order to examine the nest at close range. It was a thick-walled, rather loosely packed, four-inch globe of grasses and fine weeds with the interior well padded with plant-down, feathers and a small amount of rabbit fur. The entrance was in the side, slightly above center. The single egg, badly broken in the fall, was white, thickly spotted with tiny reddish-brown dots about the larger end and more sparingly elsewhere.

Specimens of the Beardless Flycatcher were taken at Continental on April 26; at the mouth of Madera Cañon on April 29, and at Tumacacori on May 12, 13, 15 and 16, 1931. Though a total of eleven birds was collected, it would have been possible to have taken twice that number at Tumacacori alone, along the four or five miles of river bed which was explored. At Fresnal, on the west side of the Baboquivari Mountains, on June 20 and 21, 1932, I repeatedly saw a pair of Beardless Flycatchers in a grove of small mesquites. I collected one of the

birds and, as I remember, gave it to Moore, but I do not know its location at the present time. Fresnal is considerably to the west of any previously recorded station for the species.

I have elsewhere (1930, 1934) given my reasons for believing that the northwestern race, *ridgwayi*, should be recognized.

Otocoris alpestris adusta Dwight

The Scorched Horned Lark does *not* reach its western limit at the Santa Ritas, but continues west along the mesa lands to, and all along, the east base of the Baboquivaris. Bruner (1926) has previously provisionally referred birds from this locality to the race *adusta*. Nineteen specimens were collected at the following points, though the distribution is really practically continuous, even in the grasslands of the oak association: Nogales, 1 (specimen lost en route); Atasco Mountains, 11; 5 miles west of Ruby, 1; Arivaca, 1; Altar Valley 15 miles north of the boundary, 1; east base of the Baboquivari Mountains at 5, 10, and 15 miles north of the Boundary, 5. These are all typical of the race *adusta* except that four of the nine males from the Atasco Mountains are variously paler. I incline to the belief that this paleness is a local tendency rather than evidence of intergradation with *leucansiptila*. There is as yet no evidence that *any* horned lark occurs in the breeding season between the Baboquivaris and the Colorado River Valley.

Corvus cryptoleucus Couch

White-necked Ravens were found to be fairly common at Continental in late April, common at Tumacacori in mid-May and still more numerous all along the east side of the Baboquivaris the latter part of May. Bruner (1926) records them from the west side of the mountains at Fresnal, and I suspect from various other data that they extend even further west. We saw no nests nor any indications of breeding other than that the birds were usually in pairs and a female taken at Tumacacori on May 13, 1931, was nearly ready to lay. Dr. Vorhies (1934) has recently called attention to the absence of recent records of the White-necked Raven in the valley of the Santa Cruz and suggests that the species no longer occurs there. The above records are therefore of interest as showing that it is still a common bird in the upper Santa Cruz valley (at certain times of the year at least), and also that it ranges west at least to the Baboquivaris.

Arizona winter records of this raven are not numerous. I found them to be very common all over the Sulphur Spring Valley in the winter of 1914-1915. The Dickey collection contains specimens taken by myself 4 miles west of Light on February 22, 1915, and 12 miles southeast of Willcox, February 24, 1915.

Auriparus flaviceps ornatus (Lawrence)

Verdin material from the border is unsatisfactory both as to quantity and quality and the present tentative determinations of individuals must be verified by series of fresh-plumaged specimens. Two adult males from Continental (April 24 and 26, 1931) and one from Tumacacori (May 12, 1931) are in badly abraded plumage and do not provide much in the way of color values. However, their measurements most closely approximate those of *ornatus*. A single juvenile (May 24, 1931) from the east slope of the Baboquivaris appears to be exactly like juve-

niles of *ornatus* from Saric, in northern Sonora. Compared with juveniles of *acaciarum* it is darker, grayer, and lacks the slightly buffy suffusion of *acaciarum*. Midwinter specimens from Tucson and Fort Lowell are intermediates between *ornatus* and *acaciarum*, though closer in both size and color to *ornatus*. Presumably, verdins from the southern localities given above (i. e. west to the east slope of the Baboquivaris) are in this same category.

A single adult female from Fresnal (June 20, 1932) and another from Bates Well (June 22, 1932) are so worn that no comment on them is possible. The latter is presumably of the subspecies *acaciarum*.

Progne subis hesperia Brewster

Purple Martins were seen about Arivaca, where they were apparently nesting in certain buildings. It was, of course, not possible to collect specimens in the town, but an adult male was taken on June 19, 1932, over a shallow pond, bordered by willows, about a mile south of that place. The measurements of this specimen (wing, 140; tail, 69 mm.) place it as *hesperia*. I have previously (1931) called attention to the fact that *hesperia* is the subspecies present at Tucson in May and June, and the assumption is that this name will be found to apply to all Purple Martins breeding in the Lower Sonoran Zone of southern Arizona.

Aphelocoma sordida arizonae (Ridgway)

Arizona Jays were found to be common throughout the oak belt of the Upper Sonoran Zone west to, and including, the Baboquivari Mountains. The last named range is the most westerly outpost of territory suitable for this species in southern Arizona.

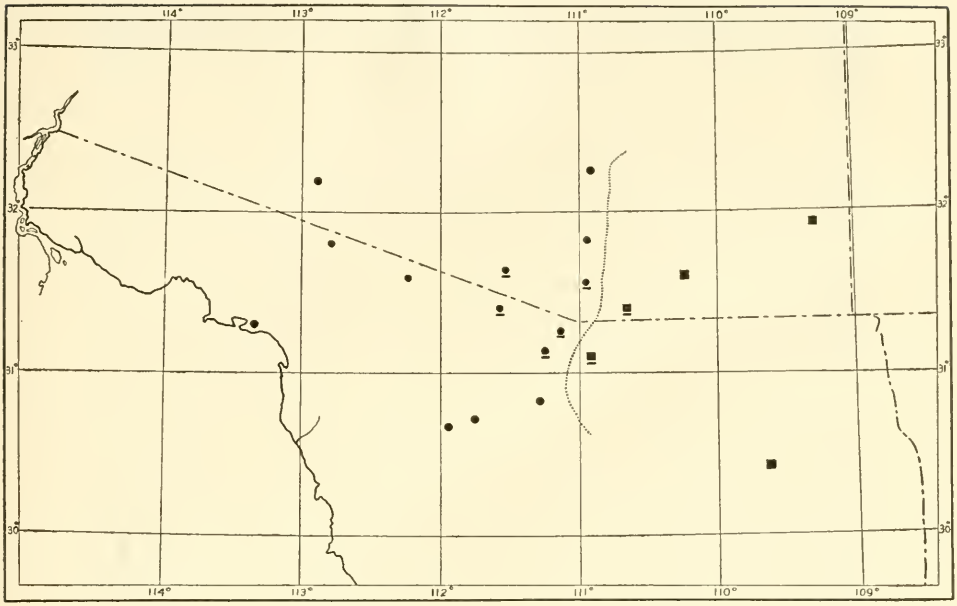
Two breeding specimens were collected in the Atasco Mountains on May 18, 1931, and one at 5500 feet altitude in Thomas Cañon in the Baboquivaris on May 27, 1931.

Sitta carolinensis nelsoni Mearns

The Rocky Mountain Nuthatch ranges west through the oak regions of the Atascos and Pajaritos to the Baboquivaris. A breeding male was taken at 5500 feet in Thomas Cañon in the Baboquivaris on May 27, 1931. Two specimens (an apparently mated pair) were taken in the Lower Sonoran cottonwoods at Tumacacori on May 13, 1931, but whether these birds were transients or were preparing to breed in the locality is unknown.

Toxostoma curvirostre palmeri (Coues)

The series of thrashers collected leaves no doubt that the dividing line between *palmeri* and *curvirostre* in extreme southern Arizona is the ridge formed by the Santa Ritas and their southern continuation, the San Cayetanos. In the valley of the Santa Cruz, *palmeri* occurs in typical form at Continental (5 specimens). Two of the three specimens from Tumacacori, some 20 miles up stream (south) from Continental, show slight but definite tendencies toward *curvirostre*, as does a single specimen from just southwest of Nogales in Sonora. Two birds from the east slope of the Baboquivaris are in this same category. It is likely that most individuals from the higher ground between Nogales and the Baboquivaris



Map 3. Distribution of *Toxostoma curvirostre curvirostre* (squares), and *Toxostoma curvirostre palmeri* (dots) in southern Arizona and northern Sonora. Bars indicate intergrades.

will be found to show certain *curvirostre* tendencies, but all those from this region which I have examined personally are certainly much better referable to *palmeri*.

I have included on the map certain Sonora stations from which I have examined specimens as an aid to a better understanding of the behavior of the species on the Arizona side of the line.

Turdus migratorius propinquus Ridgway

Robins have been reported from the Santa Ritas in winter, but not previously as breeders. They were not to be classed as common, but several nesting pairs were seen during June, 1931, in Madera Cañon, and at least four pairs were found in the quaking asp thickets near the ranger station on Mt. Wrightson. Specimens were collected on June 1, 3, and 5, at altitudes of 7000, 7000 and 8500 feet, respectively.

Hylocichla guttata polionota Grinnell

Two specimens of the Great Basin Hermit Thrush were taken in the Santa Ritas. A female, probably a migrant, was collected at 4500 feet in the oak association in Stone Cabin Cañon on April 25, 1931. A single male, whose condition and actions made it almost certain that it was breeding, was taken at 6500 feet in Madera Cañon on June 1, 1931. Other hermit thrushes were heard singing (in June) in Madera Cañon and its tributaries at altitudes up to 8000 feet, but

they were extremely shy and I was able to collect only the specimens recorded above. The (presumably) breeding male is typical of the subspecies *polionota* in size and color. The wing and tail measurements are 99 and 71 mm. respectively.

Geothlypis trichas chryseola van Rossem

Five specimens of the Golden Yellowthroat were collected at Continental between April 30 and May 4, three at Tumacacori on May 15 and one in the Altar Valley, 15 miles north of the International Boundary on May 26, 1931. All of these birds were breeding, or about to do so, and may be taken as representative of the yellowthroat populations of the localities in which they were collected. For the most part they are easily referable to *chryseola* and have wide, yellow-tinged, post-frontal bands, yellowish green dorsal coloration, and golden yellow underparts. The series as a whole, however, does not show the extreme characters of the race, and is slightly intermediate toward *scirpicola*.

It is still not possible to outline the ranges of the yellowthroats of southern Arizona with any degree of finality, save that *scirpicola* ranges east up the valley of the Gila and its tributary the Santa Cruz as far as Tucson, and that *chryseola* crosses the boundary in the valleys of the San Pedro and Santa Cruz at least to Fairbank and Continental and also occurs in the upper Altar Valley. Material to show whether or not *chryseola* occurs at the isolated reservoirs and water holes in the extreme southeastern corner of the state is lacking. The distribution of *chryseola* in Sonora and Chihuahua, however, would indicate that such is the case.

Sturnella magna lilianae Oberholser

The unmistakable song of this species was occasionally heard (though *neglecta* was certainly more common) at Continental, where Dr. Miller took a specimen on April 29, 1931. So far as I could determine, *magna* was the *only* species of meadowlark in the grasslands on the west slopes of the San Cayetano Mountains (specimen taken May 14, 1931), in the grasslands near Tumacacori (specimen taken May 15, 1931), and on the mesas along the Atasco and Baboquivari Mountains.

The subspecies *lilianae* appears to be an excellent race and easily distinguishable from *hoopesi* of the Atlantic (Rio Grande) drainage. In color, it is an almost exact duplicate of *Sturnella neglecta*, and some specimens would be virtually impossible to place with certainty were it not for the sharp division between the yellow throat and buffy white jugal area of *lilianae*.

Xanthocephalus xanthocephalus (Bonaparte)

Yellow-headed Blackbirds were observed as not uncommon transients in the cultivated ground at Continental. An adult male was collected on April 29, 1931.

Agelaius phoeniceus sonoriensis Ridgway

The breeding red-winged blackbirds of the Santa Cruz Valley are similar to those from Tucson. They are not appreciably different in color from specimens from the Lower Colorado River Valley (the metropolis of the subspecies) but have, on an average, slightly thicker and shorter bills; in fact certain extreme

individuals have bills almost as stubby as those of *fortis*. All in all, they are essentially like the type of *sonoriensis* which, as has repeatedly been noted, is a winter bird from Camp Grant, a locality well within the breeding territory of *A. p. nevadensis*. It is not improbable that the type of *sonoriensis* was simply a winter vagrant from the Santa Cruz Valley.

I agree with Swarth that the breeding redwings from east of the Santa Ritas should be called *nevadensis*.

Specimens of *sonoriensis* were collected at Continental (17), Tumacacori (2) and Arivaca (3).

Molothrus ater artemisiae Grinnell

One specimen of the Nevada Cowbird was collected at Continental on May 4, 1931. The bird, a female, was not in breeding condition and was obviously a transient in the locality.

Tangavius aeneus milleri van Rossem

Bronzed Cowbirds were occasionally seen about the ranch buildings at Los Encinos at the east base of the Baboquivaris, though invariably in the cattle corrals where it was not practicable to collect them. Several males were noted at a water tank at Fresnal at the western base of the Baboquivaris, but these birds were extremely shy and I never succeeded in getting within gunshot. Bruner (1926) has also noted the species at Fresnal. Both of the above localities are considerably to the west of the currently supposed range of this species.

Richmondena cardinalis superba (Ridgway)

Save for the old record of "Colorado River, Arizona," collected by Bischoff, the Arizona Cardinal has apparently not been detected (save by Bruner, 1926) west of the Santa Cruz River. We found it to be fairly common at Fresnal (specmen collected June 20, 1931) on the west side of the Baboquivaris, and also saw probably a dozen birds in the mesquites at Bates Well. An adult male was taken in this last named locality on June 23, 1932. Without investigation of the territory between Bates Well and the Colorado River it is not possible to suggest how much farther west the cardinal ranges, nor why it is (apparently) absent from the Lower Colorado River Valley.

On April 23, 1931, during a stop at a service station about 10 miles east of Gila Bend on the Gila Bend-Tucson highway, I saw a male cardinal in the thick growth of desert vegetation (chiefly sahuaro and mesquite) near the road, and learned from the station operator that cardinals were often seen there. There is an abrupt break in the character of the vegetation *just east of Gila Bend* and one would assume that the range of the cardinal does not extend west of that point.

Hesperiphona vespertina californica Grinnell

A solitary female, whose condition indicated that she was incubating, was shot at 8500 feet altitude near the summit of Mt. Wrightson, in the Santa Ritas, on June 5, 1931. I cannot distinguish this single bird from females from the mountains of California and southern Nevada. It is, definitely, not *montana*. I

shall elsewhere (MS. in press) advance reasons for the recognition of the subspecies *californica* as distinct from *brooksi*.

Pipilo fuscus mesoleucus Baird

The Cañon Towhee in typical form ranges west to the east slope of the Baboquivari Mountains (specimen taken May 24, 1931). West of these mountains we found towhees to be common at Fresnal (2 specimens taken June 21 and 22, 1932) and not rare at Bates Well (3 specimens taken June 23, 1932). These birds from west of the last Upper Sonoran outpost in the Baboquivaris are slightly darker and grayer than typical *mesoleucus* in comparable plumage, but larger series in fresh plumage are necessary in order to verify the comparative characters shown in worn, breeding specimens.

Why this species ranges across a hundred miles of Lower Sonoran Desert between the Baboquivaris and Bates Well and does not continue on to the Colorado River is a question which cannot be answered until more is known about the character of the country for the remaining distance.

Aimophila ruficeps scottii (Sennett)

In the San Cayetano, Atasco, Pajarito and Baboquivari Mountains, this sparrow is a common inhabitant of all grass or cactus-grown slopes and specimens were collected in all localities except the Baboquivaris. However, the species is, as above stated, common there.

Spizella carpalis carpalis (Coues)

Moore (1932) has already recorded the collecting of four specimens of the Rufous-winged Sparrow at Fresnal, on June 20 and 21, 1932. My familiarity with this species in Sonora indicated that Fresnal provided an association, (a mesquite-cactus-grass growth on broken, gravelly ground) eminently suitable for its presence and I described the bird to Moore in hopes that one of us might detect one. Moore took three individuals on the afternoon of the 20th and one the following morning. I, personally, saw only a single individual and collected none.

The purpose of mentioning this previously published record of the supposedly extinct (in Arizona) species is to call attention to the bird's typical habitat. It is *not* an inhabitant of grassland plains, other than as a possible casual, but occupies, normally, very much the same ecologic niche as *Amphispiza bilineata*.

I do not think that the Rufous-winged Sparrow can be considered rare in south-central Arizona. It is, however, obviously very local and this, combined with its close resemblance to *Spizella passerina*, has doubtless led to an erroneous assumption of rarity.

This species is a typical *Spizella* in almost every respect and why it has been considered an "*Aimophila*" is incomprehensible.

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PLATE 18

Fig. 1. Upper Sonoran oak and grass association in the Atasco Mountains. View looking northward down Piskiorski Cañon. Although this region is inhabited chiefly by Upper Sonoran species, certain Lower Sonoran birds, such as *Otocoris alpestris adusta* and *Sturnella magna lilianae*, were found to be fairly common along the bare-topped ridges.

Fig. 2. Grass plains along the eastern base of the Baboquivari Mountains. Here terminate, westwardly, the ranges of several Lower Sonoran species and subspecies of birds, among them *Callipepla squamata pallida*, *Otocoris alpestris adusta*, *Corvus cryptoleucus*, and *Sturnella magna lilianae*. The Upper Sonoran (oak) Zone of these mountains forms the western outpost of that association along the boundary.

Fig. 1

Fig. 2

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CROTALUS MITCHELLII, THE SPECKLED RATTLESNAKE

BY

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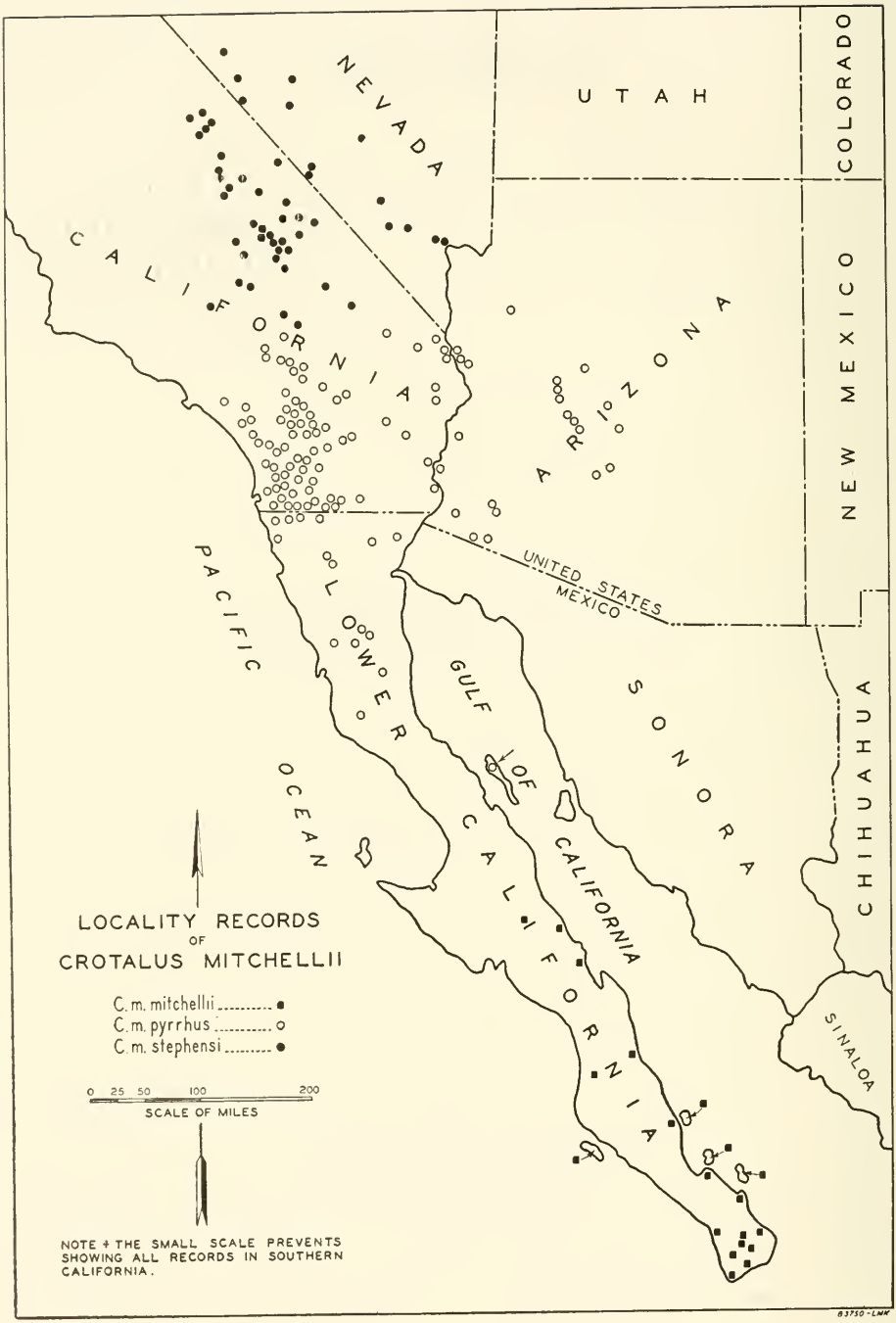
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CROTALUS MITCHELLII, THE SPECKLED RATTLESNAKE

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INTRODUCTION

Crotalus mitchellii, a rattlesnake of the southwestern United States and Lower California, is characterized by great variability of head scalation, pattern, and color. This morphological plasticity has rendered the determination of its status and relationships somewhat difficult. It is the purpose of this paper to present the results of a reinvestigation of the form, largely based on specimens lately acquired; especially worthy of mention is a series from the Cape region of Lower California, the first available from that area in sufficient numbers to permit a statistical analysis.

HISTORICAL

Crotalus mitchellii was first described by Cope in 1861[1] as *Caudisona Mitchellii,* based on a specimen (USNM 5291½) collected by John Xantus at Cape St. (San) Lucas, Lower California. The snake was named in honor of Dr. S. Weir Mitchell, the famous Philadelphia neurologist, scientist, and author, who was at that time engaged in researches on rattlesnake venoms. In 1866[2] Cope described as *Caudisona pyrrha* a specimen (USNM 6606) collected by Dr. Elliott Coues at Canyon Prieto, near Fort Whipple, Yavapai County, Arizona.[3] Cope recognized the affinity of this new form with *mitchellii.*

Writing in 1893 (published in 1895) Stejneger[4] considered *pyrrhus* a subspecies of *mitchellii.* In 1894, with new material available from Lower California, Van Denburgh[5] showed that the differences which

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[1] Proc. Acad. Nat. Sci. Phila., 1861, p. 293.

[2] Proc. Acad. Nat. Sci. Phila., 1866, p. 308.

[3] A graphic contrast between the difficulties faced by the collectors of the past, as compared with the facilities of the present, is afforded by Coues' reference to this specimen: "It is not in the best order, as it was procured under the untoward circumstances of a hasty retreat from hostile Indians."

[4] Rept. U. S. Nat. Mus. for 1893, 1895, p. 456.

[5] Proc. Cal. Acad. Sci., Ser. 2, Vol. 4, p. 450.

Cope had used to segregate *pyrrhus* from *mitchellii* failed to hold in a larger series; he therefore placed *pyrrhus* in the synonymy of *mitchellii,* where it has since remained.

A closely allied species, *Crotalus tigris,* must now be surveyed; this was first described by Kennicott from southern Arizona in 1859.[6] In reporting the results of the Death Valley Expedition, Stejneger[7] classified, as belonging to this species, certain rattlesnakes collected in east-central California and southern Nevada. In 1929 Amaral,[8] noting the similarity of this California-Nevada material with *mitchellii,* considered the latter a subspecies of *tigris.*

The present writer[9] reviewed the situation in 1930 and reached the conclusion that these California-Nevada snakes were different from the true Arizona *tigris.* Noting border-line specimens from Mineral and Esmeralda Counties, Nevada, which showed certain affinities to *Crotalus confluentus lutosus,* I considered these as coming within the *confluentus* group, and applied to the snakes from California and Nevada, formerly considered *tigris,* the name *Crotalus confluentus stephensi.* As the relationship between this form and *mitchellii* was evident, the latter became *Crotalus confluentus mitchellii.*

This classification led to a curious anomaly, namely, the presence of two subspecies in the same territory without intergradation, for, in southern California, *Crotalus confluentus oreganus* and *C. c. mitchellii* occupy extensive areas together. Of the ring *oreganus-lutosus-stephensi-mitchellii* connecting these forms, clearly the *lutosus-stephensi* link was the weakest. With the considerable additional material that has come to hand I am now inclined to the belief that the Mineral-Esmeralda (Nevada) specimens are pure *stephensi,* rather than *lutosus-stephensi* intergrades.

Gradually new material, especially in the Museum of Vertebrate Zoology, has brought the *lutosus* and *stephensi* ranges together in other areas and this without any approach toward intergradation; that is, the border specimens of one species do not show a tendency toward the other form, each retaining its individuality. While an actual overlap in ranges has not yet been shown, thus finally settling the *lutosus-stephensi* non-intergradation beyond question, still such an overlap is indicated as

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6 Rept. U. S. Mex. Boundary Survey, Vol. 2, 1859, p. 14.

7 North American Fauna, No. 7, 1893, p. 214.

8 Bull. Antivenin Inst. Am., Vol. 2, 1929, p. 82.

9 Trans. S. D. Soc. Nat. Hist., Vol. 6, No. 3, 1930, p. 95.

probable, particularly in the Belted Range in Nevada. Thus it is my present conclusion that *mitchellii* (and with it *stephensi*) should be divorced from the *confluentus* group.

At the same time the augmented collections of the past four years from other areas, particularly the large series from the Cape region of Lower California, together with a study of additional characters, have convinced me that these Cape specimens are different in several particulars, especially head size and rattles, from those found in Arizona and California and therefore *pyrrhus* should be revived as the subspecific name for the latter form.

Concerning the relationship of the *mitchellii* group with *tigris* I have not changed my previously expressed opinions.[10] While *mitchellii* (especially as exemplified by the Cape subspecies) is closely allied to *tigris*, there is an actual overlap of the ranges of the two species, without intergradation, in central Arizona. *Tigris* is a species which, as far as now known, is restricted to central and southern Arizona, and Sonora; its differences from *stephensi* are quite definite and consistent.

Thus at present I view *mitchellii* as comprising three subspecies as follows:

Crotalus mitchellii mitchellii: Cape and central areas of Baja California.

Crotalus mitchellii pyrrhus: Central and southwestern Arizona; the Californias from central San Bernardino County south to the Sierra San Pedro Mártir of Baja California.

Crotalus mitchellii stephensi: Cailfornia, east of the Sierras from Inyo County south to central San Bernardino County; southwestern Nevada.

In the outline which follows there are presented first, descriptions of these forms, their ranges and morphology, followed by a discussion of the characters in which they differ from, or resemble, each other and closely allied species. In these data advantage is taken of the enlarged collections now available and of studies of variation which have been made preparatory to a general summary of rattlesnake characters.

Mitchellii is a peculiar snake in that a tendency to subdivision of its head scales renders their classification difficult; also it is, amongst all the rattlesnakes, the most variable in color and pattern. The separation

[10] Trans. S. D. Soc. Nat. Hist., Vol. 6, No. 3, 1930, p. 106; *ibid.* Vol. 6, No. 24, 1931, p. 353.

of the rostral from the prenasals by a row of granules or small scales, long thought to be a simple and universal criterion of *mitchellii*, is not always present in this form, even if we omit the subspecies *stephensi* from consideration; also this separation sometimes occurs in certain other species, notably *C. c. oreganus* from Arizona. Thus a simple and invariable key character for this group is not available.

Mitchellii has often been called the White, Bleached, or Faded Rattlesnake, especially based on specimens from southwestern Arizona, which happen to have been among the first to be brought east alive. But from many sections it is brightly colored and strongly, although indefinitely, patterned. I deem it best to refer to the two more typical subspecies as Speckled Rattlesnakes, for the punctations which constitute the pattern are its most outstanding characteristic.

Crotalus mitchellii mitchellii (Cope)

San Lucan Speckled Rattlesnake

Plate 19, fig. 1

1861 *Caudisona Mitchellii* Cope, Proc. Acad. Nat. Sci. Phila., 1861, p. 293. (Type locality: Cape St. (= San) Lucas, Lower California, Mexico. Type specimen: USNM 5291½[11] collected by John Xantus.)

1875 *Crotalus mitchellii* Cope, in Yarrow Surv. W. 100th Merid., Vol. 5, p. 535.

1882 *Crotalus mitchelli* Yarrow, Bull. U. S. Nat. Mus., No. 24, pp. 12, 73.

1883 *Crotalus oreganus* var. *mitchelli* Garman, Mem. Mus. Comp. Zoöl., Cambr., Vol. 8, No. 3, p. 173.

1887 *Crotalus mitcheli* Belding, West American Scientist, Vol. 3, No. 24, p. 98.

1887 *Crotalus mitchillii* Cope, Bull. U. S. Nat. Mus., No. 32, p. 90.

1894 *Crotalus mitchellii* (part) Van Denburgh, Proc. Cal. Acad. Sci., Ser. 2, Vol. 4, p. 450.

1895 *Crotalus Mitchellii Mitchellii* Stejneger, Rept. U. S. Nat. Mus. for 1893, p. 454.

1929 *Crotalus tigris mitchellii* (part) Amaral, Bull. Antivenin Inst. Am., Vol. 2, No. 4, p. 82.

1930 *Crotalus confluentus mitchellii* (part) Klauber, Trans. S. D. Soc. Nat. Hist., Vol. 6, No. 3, p. 108.

Material.—Of this subspecies 81 specimens from the Cape region of Baja California have been available for study, of which fifty were seen alive. In addi-

[11] This specimen has apparently disappeared; in fact, Dr. Stejneger says it had been removed from the USNM collection before his coming to the museum fifty years ago. It has not been located amongst the Cope material in the collection of the Academy of Natural Sciences of Philadelphia.

tion there are 5 specimens from three different Gulf of California islands; the latter however are omitted from the descriptive summary as it is not desired to complicate the statistics with possible incipient island subspecies. No specimens are available to me from the central area of the peninsula (the vicinity of Mulegé, Santa Rosalía, and San Ignacio). There are five specimens in the Paris Museum from this area; of these Mr. F. Angel has kindly supplied me the measurements. These indicate that the speckled rattlesnakes of that vicinity, while intermediate between *C. mitchellii mitchellii* and *C. m. pyrrhus*, are somewhat closer to the former, so they have been included therewith. The affiliation is not unexpected, for in many kinds of reptiles the Cape species extend to the central area with a break between these and the San Diegan forms further to the north. Thus in the present instance we consider *C. m. mitchellii* to extend as far north as San Ignacio. The most southerly available specimen of *pyrrhus* is from the Sierra San Pedro Mártir;[12] we assume that, in this gap of about 250 miles, intergradation, which is begun in the San Ignacio area will be found complete, for this intervening territory is of a character suitable to *C. mitchellii*.

Range.—*C. m. mitchellii* has been collected at the following localities in the southern and central areas of Lower California, and adjacent islands on the Gulf of California and Pacific coasts. (See map). For a few localities approximate latitudes are given where the identity, through duplication of names or obscurity, may be confusing.

Cape San Lucas (Type locality)
San José del Cabo
Sierra El Taste
Sierra San Lazaro
Miraflores
Todos Santos (23°30′)
La Rivera (Riberia)
Agua Caliente (23°30′)
Ensenada de los Muertos (24°)
La Paz
San Evaristo (24°50′)
Santo Domingo (25°30′)
Punta Escondido (25°50′)
Mulegé
Santa Rosalía
San Ignacio
Ceralvo Island
Espiritu Santo Island
San José Island
Santa Margarita Island

Lepidosis and Form.—Size medium among rattlesnakes. Scale rows at midbody usually 25 (90 per cent), rarely 23 (6 per cent) or 27 (4 per cent). The scales are strongly keeled, except the first row on each side. Scale bosses are rather conspicuous. Ventrals: males, (52 specimens) max. 181, min. 165, av. 176.69±0.32 interquartile range 174.4—179.0, coefficient of variation 2.0 per cent; females, (27 specimens) max. 186, min. 172, av. 179.44±0.45, interquartile range 177.1—181.8, coefficient of variation 1.9 per cent. Anal entire. Caudals: males 28 to 22, average of 44 specimens 25.1±0.12; females 23 to 16, average of 27 specimens 20.7±0.21. The caudals, while generally entire, may have a few at either end of the series divided.

The supralabials usually number 15 (24 per cent), 16 (49 per cent), or 17

[12] An intermediate specimen from Las Huevitas (sometimes given as Huavitas or Cuevitas) near San Fernando Mission, contained in the California Academy of Sciences collection, was destroyed in the fire of 1906.

(16 per cent); occasionally 14 (4 per cent) or 18 (6 per cent); rarely 13 or 19 (less than 1 per cent of each). The infralabials generally number 15 (39 per cent) or 16 (37 per cent); occasionally 14 (10 per cent) or 17 (13 per cent); rarely 13 (less than 1 per cent). The posterior supralabials are often divided horizontally, thus being lower than the scales next above.

The rostral is usually wider than high, as is characteristic of this species; however in 10 per cent the width and height are equal and in 7 per cent it is higher than wide. As is usually the case with this species the prenasals are separated from the rostral by rows of scales or granules; only 3 per cent make contact.

The prenasals are also usually separated from the supralabials by the extension to the rostral of the small scales anterior to the pit; this separation is evident in 83 per cent of the specimens examined. The internasals cannot be counted with accuracy as they form part of the row of scales which, continued down along the sides of the rostral, separate that scale from the prenasal. In fact this tendency, which is so characteristic of *mitchellii*, of splitting such scales as the prenasals, loreals, canthals, and preoculars, renders a statistical analysis of the head scales difficult and to some extent useless. Therefore, only the more important items are cited.

The scales on the crown anterior to the supraoculars vary from 25 to 46, interquartile range 31.5 to 37.9, average 34.7. The minimum scale rows between supraoculars vary from 1 to 8, interquartile range 4.7—6.3, with an average of 5.5.

Supraocular sutures or indentations are present in only 3 per cent of the specimens. The nasals are 2—2. About 60 per cent of the specimens have two loreals, the rest from 1 to 4. The scales along the canthus rostralis from rostral to supraocular usually number from 5 to 7.

The upper preocular is frequently split horizontally, vertically, or both; there results confusion with both loreals and canthals so that the classification of these scales and the determination of their contacts, useful in the classification of some species, is here usually impossible. There is often a small, circular scale between the two preoculars; this is quite characteristic of this subspecies, but is not invariably present.

The scale rows from labials to orbit usually number 3 or 4; the scales in the orbital ring average about 9.

The first infralabials are undivided; normally, 2 or 3 are in contact with the genials on each side.

The mental is triangular. The genials are in a single pair, relatively short and obtuse. Intergenials are present in only one per cent of the specimens and submentals in 2 per cent.

In shape the head is subtriangular and depressed, as compared with most rattlesnake species. The average ratio of body length to head length in adults (over 700 mm. in length) is 24.6. The ratio of the distance across the supraoculars to the space between averages 2.5.

The average ratio of the length of tail to total length exclusive of rattle is 0.080 in adult males and 0.063 in females.

The largest specimen examined measured 958 mm. (39 in.) when alive.

Color and Pattern.—This snake is light-gray or tan in ground color with a dorsal series of large and highly irregular blotches which almost obscure the ground.

The blotches are neither clearly outlined nor of regular form; they consist partly of darker scales, but more conspicuously of large aggregations of black or dark-brown punctations. The blotch centers are usually somewhat lighter than the edges. Toward the tail the blotches become rings. Secondary and, occasionally, tertiary series of blotches are in evidence on the sides. The inter-blotch light areas are freest of punctations along the mid-dorsal line, but even here the ground color is seldom spotless. As a result, the live snake usually gives the impression of a quiet, gray or brown neutrality. The extreme color variations found in *pyrrhus* in California and Arizona do not seem to be present in this southern race. Below, the color is buff, with aggregations of dark spots.

The head is spotted but is neither conspicuously nor regularly marked. There is a dark line from the eye to a point above the angle of the mouth. The outer edge of each supraocular usually has a conspicuous, light tip.

The tail rings are alternating ash-gray and black, in some contrast to the rest of the body. The light are usually wider than the dark rings, thus following *scutulatus* rather than *atrox*.

In number the body blotches vary from 26 to 39, the average being 31.7 $\pm$0.23 in the males and 32.0$\pm$0.36 in the females. The coefficient of variation is about 8 per cent in this characteristic.

The tail rings number 3 to 5 in the males, with an average of 3.8$\pm$0.06, and 3 or 4 in the females (average 3.2$\pm$0.05).

Crotalus mitchellii pyrrhus (Cope)

SOUTHWESTERN SPECKLED RATTLESNAKE

Plate 19, fig. 2 and Plate 20, fig. 1

1866 *Caudisona pyrrha* Cope, Proc. Acad. Nat. Sci. Phila., 1866, p. 308. (Type locality: Canyon Prieto, Yavapai County, Ariz. Type specimen: USNM 6606 collected by Dr. E. Coues).

1875 *Crotalus pyrrhus* Cope, in Yarrow, Surv. W. of 100th Merid., Vol. 5, p. 535.

1883 *Crotalus confluentus* var. *pyrrhus* Garman, Mem. Mus. Comp. Zoöl., Cambr., Vol. 8, No. 3, p. 173.

1894 *Crotalus mitchellii* (part) Van Denburgh, Proc. Cal. Acad. Sci., Ser. 2, Vol. 4, p. 450.

1895 *Crotalus Mitchellii pyrrhus* Stejneger, Rept. U. S. Nat. Mus. for 1893, p. 456.

1896 *Crotalus mitchelli* (part) Boulenger, Cat. Snakes, Brit. Mus., Vol. 3, p. 580.

1922 *Crotalus goldmani* Schmidt, Bull. Am. Mus. Nat. Hist., Vol. 46, Art. 11, p. 701. (Type locality: El Piñon, 5300 ft., San Pedro Mártir Mts., Lower California. Type specimen: USNM 37573 collected by Nelson and Goldman).

1929 *Crotalus tigris mitchellii* (part) Amaral, Bull. Antivenin Inst. Am., Vol. 2, No. 4, p. 82.

1930 *Crotalus confluentus mitchellii* (part) Klauber, Trans. S. D. Soc. Nat. Hist., Vol. 6, No. 3, p. 108.

Material.—I have had a considerable field and reptile-house experience with this form, particularly in southern California, and have seen in excess of four hundred live specimens. The following preserved specimens have been available for study:

ARIZONA:		
Yavapai County	14	
Maricopa County	7	
Yuma County	3	
Mohave County	3	27
CALIFORNIA:		
San Bernardino County	21	
Riverside County	14	
Imperial County	8	
San Diego County	96	139
Northern Lower California:		13
Angel de la Guarda Island:		5
Unknown		1
	TOTAL	185

Range.—*C. m. pyrrhus* is extensively distributed in rocky situations in central and western Arizona, southern California, and northern Lower California. (See map). It is certainly present but has not yet been recorded in northwestern Sonora. The known localities of collection are as follows:

ARIZONA

YAVAPAI COUNTY:
- Canyon Prieto, near Ft. Whipple (Type locality)
- Drake
- Hillside
- Date Creek
- Congress Junction

MARICOPA COUNTY:
- Wickenburg
- 8 mi. SE. of Wickenburg
- Hot Springs Junction
- Cave Creek
- Black Canyon, 25 mi. N. of Phoenix
- Estrella Mts.
- Mts. S. of Phoenix
- Near Phoenix

YUMA COUNTY:
- Mohawk Mts.
- Tule Mts.
- Tinajas Altas Mts.
- Gila Mts.
- Gonzales Well
- 20 mi. N. of Picacho
- 5 mi. N. of Mohawk, near Gila River

MOHAVE COUNTY:
- 2 mi. SW. of Valentine
- Chemehuevis Mts.
- Foot of The Needles
- Topock

CALIFORNIA

SAN BERNARDINO COUNTY:

3 mi. N. of Topock Bridge
Beal
Klinefelter
Mountain Spring
(N. end Piute Mts.)
14 mi. NE. of Blythe Junction
Gilroy Canyon, Providence Mts.
Turtle Mts.
Twentynine Palms
Key's Ranch
Windmill Tank
Old Woman Spring
9 mi. S. of Old Woman Spring
Cushenbury Spring
Cushenbury Grade
Bet. Cushenbury Spring and
Lake Baldwin
Johnston Ranch below
Lake Baldwin
Forest Home
Lucerne Valley
Deadman's Point
12 mi. S. of Barstow
Oro Grande
Victorville

RIVERSIDE COUNTY:

Palen Mts.
10 mi. N. of Desert Center
6 mi. SW. of Shaver's Well
5 mi. E. of Mecca
1 mi. S. of Indian Wells
Palm Springs
Murray Canyon near Palm Canyon
Mouth San Andreas Canyon
Whitewater
Santa Rosa Mts.
Coahuila Mt.
Nightingale Ranch
Ribbonwood
Asbestos Spring
Poppet Flat
Vanderventer Flat
Pinyon Flat
Banning

RIVERSIDE COUNTY (continued):

Schain's Ranch Road, 5 mi. W.
of Banning
Between Idyllwild and Keen Camp
S. Fork, San Jacinto River
Hemet
Temescal Canyon
San Juan Canyon, Elsinore Mts.
5 mi. E. of San Juan Hot Springs

ORANGE COUNTY:

3 mi. E. of Hot Springs in
Elsinore Mts.

IMPERIAL COUNTY:

Near Picacho
Near Seeley
Coyote Wells
Myers' Creek Bridge
Mountain Spring
Boulder Park

SAN DIEGO COUNTY:

Point Loma
Mission Valley
Fallbrook
Pala
Escondido
Mission Gorge
Lakeside
El Monte
Lakeview (Johnstown)
El Cajon
Dehesa
Rincon
Warners Ranch
Valley Center
Lake Wohlford
Sutherland
Santa Ysabel
Ramona
San Vicente
Wildwood
Shady Dell
Padre Barona
El Capitan Dam
Mussey
Boulder Creek

San Diego County (continued):

Twin Brooks
Viejas
Descanso
Alpine
Pine Valley
Suncrest
Japatul
Glen Lonely
Jamul
Lawson Valley
Lyons Valley
Barrett Dam
Deerhorn Flat
Dulzura
Cottonwood
Tecate
Potrero
Campo
Clover Flat
Live Oak Springs
Hipass

San Diego County (continued):

Palomar Mt.
Cuyamaca Mt.
Laguna Mt.
Laguna Junction
Coyote Canyon
Collins Valley
Culp Valley
Borego Palm Canyon
Tubbs' Spring
San Felipe Valley
Sentenac Canyon
La Puerta (Mason Valley)
Grapevine Spring
Yaqui Well
The Narrows
Vallecito
Boulevard
Jacumba
Carrizo Gorge
Near Mountain Spring
Dos Cabezas

There are, in the literature, two Los Angeles County records, namely, Fairmont and Lovejoy Springs. It is not improbable that these are the results of inaccurate identifications, particularly the former, and therefore they are not regularly listed above.

Baja California

East Base, Cocopah Mts.
Volcano Lake
Garcia (S. D. & A. Ry.)
Redondo (S. D. & A. Ry.)
Tecate
8 mi. E. of Valentín
4 mi. N. of San Pedro (32°5′)
Laguna Hanson
Descanso (32°15′)
San Antonio (near Socorro)
San Matias (31°15′)
San José (31°)
Parral (30°40′)
El Piñon, San Pedro Mártir Mts. (Type locality of *goldmani*).
Las Huevitas (Lat. 30°)
Angel de la Guarda Island

Lepidosis and Form.—Size large among rattlesnakes. Scale rows at midbody usually 25 (71 per cent), occasionally 23 (19 per cent), or 27 (10 per cent). The scales are strongly keeled, except the first row on each side. Ventrals: males (110 specimens), max. 185, min. 168, av. 177.56±0.21, interquartile range 175.3—179.8, coefficient of variation 1.9 per cent; females (53 specimens), max. 187, min. 163 (170 if one aberrant specimen be omitted), av. 179.25±0.39, interquartile range 176.4—182.1, coefficient of variation 2.3 per cent. Anal entire. Caudals: males 28 to 20, average of 110 specimens 23.7±0.10; females 23 to 16, average of 51 specimens 19.1±0.17. The caudals, while generally entire, may have a few at either end of the series divided.

The supralabials vary from 13 to 19; they usually number 15 (25 per cent), 16 (36 per cent), or 17 (27 per cent); occasionally 14 (5 per cent) or 18 (6 per cent); rarely 13 or 19 (less than 1 per cent of each). The infralabials generally number 15 (20 per cent), 16 (39 per cent), or 17 (26 per cent); occasionally 14 (7 per cent) or 18 (6 per cent); rarely 13 or 19 (less than 1 per cent of each).

The rostral is usually wider than high; however, this is by no means the important characteristic it has been often assumed, since 18 per cent of the specimens examined were higher than wide and 30 per cent were equal in the two dimensions. The prenasals are normally not in contact with the rostral, this lack of contact being highly characteristic of the present species. However, in 6 per cent of the specimens examined, contact is made on one side and in 12 per cent on both; thus 82 per cent run true to form, but in the others this key character partly or entirely fails. The prenasals are in contact with the supralabials in 24 per cent of the cases; the contact is entirely prevented in 32 per cent by the extension to the rostral of the small scales anterior to the pit, and the contact is partly prevented by these same scales in the remaining 44 per cent. The internasals are indeterminate since the nasals do not ordinarily contact the rostral.

The scales on the crown anterior to the supraoculars number at least 21 and average about 35. The minimum scale rows between supraoculars vary from 4 to 8, interquartile range 5.2—6.5, average 5.9.

Sutures or indentations are present in 9.3 per cent of the supraoculars. The nasals are 2—2. The loreals are often identified with difficulty; they vary from 0 to 4, with an average of about 1.5.

The upper preocular is frequently split, horizontally, vertically, or both; in fact, in only 28 per cent of the cases is it entirely intact, and in no less than 34 per cent is split in both directions.

The scale rows from labials to orbit usually number from 2 to 4. There are from 7 to 12 scales in the orbital ring, most specimens having 8 or 9.

The first infralabials are often divided (22 per cent divided, 78 per cent undivided).

The mental is triangular. The genials are in a single pair, relatively short and obtuse. Intergenials are present in 7.8 per cent of the specimens; submentals in only 1.4 per cent.

In shape the head is subtriangular, and depressed as compared with most species of the genus. The average ratio of body length to head length in adults (over 700 mm. in length) is 21.5.

The ratio of the length of tail to total length exclusive of rattle is approximately 0.072 in adult males, and 0.057 in females.

The largest specimen examined measured 1295 mm. (51 in.); the smallest 303 mm. (12 in.).

Color and Pattern.—This is the most variable of all the rattlesnakes in color and pattern; its bewildering variety renders any considerable accuracy or consistency of description quite impossible.

The ground color may be white, cream, tan, buff, drab, gray, brown, pink, orange, or salmon. On this there is superimposed a series of blotches which may approach hexagons, hour-glasses (with transverse axes), diamonds, rectangles, or cross-rings. The blotches consist partly of dark-colored scales and partly of dark

punctations; these two forms of color application may blend or be in strong contrast. The blotches may be pink, salmon, red, brown, gray, black, or mixtures of these. They are usually highly irregular and indefinite in outline. There is also present a secondary series of blotches on each side; these may be of the same or twice the frequency of the main series. Caudad the two series are confluent to form transverse rings. A tertiary series is sometimes present.

The ground color is usually freest from punctations along the mid-dorsal line; along the sides gray punctations and even a gray suffusion are likely to be present, this being particularly the case with Mohave Desert specimens toward the *stephensi* range. Black scale tips are often present as in *stephensi*. Sometimes the blotches have light centers. The lower surfaces are cream, buff, or pink, usually blotched or punctated. The head is irregularly blotched or spotted. A postocular dark line is sometimes present. Supraocular light cross-dashes or light outer edges are often in evidence.

The tail rings are frequently in considerable color contrast with the body blotches, the terminal rings being usually black, even though the body be pink. An ash-gray ground color on the tail, of the *atrox* and *scutulatus* type, may be present.

In some areas this snake maintains a rather consistent coloration. Thus, in Yavapai County, Arizona, from Wickenburg north it is almost invariably a beautiful pink or salmon-red, a color which, by-the-way, fades badly in preservation, so that these snakes must be seen alive to observe the full effect. Pink, however, is not a universal Arizona coloration, since the mountains to the south of Phoenix produce light grayish-green specimens, while those from the Yuma sector are tan. In the Elsinore Mountains of Orange and Riverside counties, California, there is found a color variety in a beautiful shade of orange, with blotches of burnt-orange. In some sections of the Mohave Desert the snakes are russet-brown.

The lightest specimens I have seen came from the Tinajas Altas Mts., Yuma County, Arizona. In these the ground color is creamy-white; individuals from this area originally caused *mitchellii* to be known as the "White Rattlesnake." (Plate 20, fig. 1). It is said that these snakes blend well with a white granite found in that vicinity.

However, that these color varieties are not always territorially consistent is shown by the snakes of San Diego County, where, although grays and browns predominate, pink, salmon-red, and buff individuals are also present. Occasionally specimens are found with black scales or blotches on a light-gray ground; this form has locally been well termed the "granite rattler."

The body blotches number from 23 to 42, the average for the males being 33.7 ± 0.18 and for the females 32.9 ± 0.28. The tail rings average 5.6 ± 0.06 in the males (range 4 to 9), and 4.4 ± 0.08 in the females (range 3 to 6).

Crotalus mitchellii stephensi Klauber

Panamint Rattlesnake

Plate 20, fig. 2.

1893 *Crotalus tigris* Stejneger, North American Fauna, No. 7, p. 214.

1896 *Crotalus tigris* (part) Boulenger, Cat. Snakes Brit. Mus., Vol. 3, p. 580.

1929 *Crotalus tigris tigris* (part) Amaral, Bull. Antivenin Inst. Am., Vol. 2, No. 4, p. 82.

1930 *Crotalus confluentus stephensi* Klauber, Trans. S. D. Soc. Nat. Hist., Vol. 6, No. 3, p. 108. (Type locality: 2 mi. W. of Jackass Springs, 6200 ft., Panamint Mts., Inyo County, Calif. Type specimen: MVZ 6699 collected by Dr. Jos. Grinnell).

1933 *Crotalus mitchellii* (part) Stejneger and Barbour, Check List N. A. Amph. and Repts., 3d Ed., p. 136.

Material.—Of this subspecies there have been available for study, the following:

NEVADA:		
Mineral County	1	
Esmeralda County	6	
Nye County	6	
Clark County	3	16
CALIFORNIA:		
Mono County	1	
Inyo County	43	
Kern County	1	
San Bernardino County	5	50
TOTAL		66

About thirty individuals of this form have been seen alive.

Range.—*C. m. stephensi* is an inhabitant of the desert-mountain region lying east of the crest of the Sierra Nevada from Round Valley, Mono Co., California and southern Mineral County, Nevada, south to central San Bernardino County, California. (See map). The southern boundary may be roughly indicated by a line drawn from Barstow, California to Searchlight, Nevada along which line it intergrades with *pyrrhus*. Eastward it ranges at least to the Belted Mts., Nye County, Nevada, and Boulder Dam, Nevada; its presence beyond the Colorado River is not yet established. The following are the known localities of collection:

NEVADA

MINERAL COUNTY:
- Endowment Mine, Excelsior Mts.

ESMERALDA COUNTY:
- 7 Mi. N. of Arlemont
- McAfee Ranch (near Mono Co. border)
- 1.7 Mi. S. of Goldfield
- Lida
- 7 Mi. S. of Tonopah

NYE COUNTY:
- Grapevine Mts., above Salt Wells
- Bullfrog
- Near Oak Spring, Belted Range (½ Mi. S., 1 M. S., 4 Mi. SE., ½ Mi. NW.)

CLARK COUNTY:
- Indian Spring Valley
- Las Vegas Valley
- Las Vegas Wash
- Boulder Dam Site
- Harris Spring, Charleston Mts.

California

Mono County:
N. end Round Valley

Inyo County:
Rocky Creek above Round Valley
Birch Creek, W. of Bishop
Bishop Creek
(6, 6½, 7, 7½, 9, 10, 11 and 12 mi. W. of Bishop)
2 Mi. S. of Aberdeen
2 Mi. W. of Independence
Independence Creek
Mesquite Spring (N. end Death Valley)
Beveridge Canyon
Lone Pine
Carroll Creek
2 Mi. W. of Jackass Spring (Type locality)
Emigrant Canyon, Panamint Mts.
Coso Valley
Dante's View, Black Mts.
Wild Rose Spring
Maturango Spring

Inyo County (continued):
Junction Ranch
Hanaupah Canyon, Panamint Mts. (Hananpole or Hannopee)
Johnson Canyon, Panamint Mts.
Goler Canyon, Panamint Mts.
Near Ballarat (6 mi. S.; 7 and 10 mi. SW.)
Shepherd Canyon, Argus Mts.
Little Lake

San Bernardino County:
Slate Range, NW. of Borax Flat
Willow Creek, Panamint Mts.
5 Mi. S. of Cave Spring
4 Mi. NE. of Randsburg
Odessa Canyon, Calico Mts.
Near Baker
Coolgardie
Yermo

Kern County:
Last Chance Canyon
Near Mohave
6 Mi. E. of Brown

Lepidosis and Form.—Size medium among rattlesnakes. Scale rows at midbody usually 23 (73 per cent), occasionally 25 (25 per cent), rarely 21 (2 per cent). The scales are keeled, except the first row on each side. Ventrals: males (32 specimens), max. 181, min. 162, av. 174.44±0.50, interquartile range 171.6—172.2, coefficient of variation 2.4 per cent; females (22 specimens), max. 182, min. 173, av. 178.72±0.40, interquartile range 176.8—180.6, coefficient of variation 1.6 per cent. Anal entire. Caudals: males 28 to 23, average of 33 specimens 25.0±0.16; females 22 to 17, average of 22 specimens 19.4±0.21. The caudals, while generally entire, may have a few at either end of the series divided.

The supralabials usually number 13 (20 per cent), 14 (33 per cent), or 15 (39 per cent); rarely 12 or 16 (4 per cent of each). The infralabials generally number 14 (38 per cent), 15 (42 per cent), or 16 (11 per cent); occasionally 13 (4 per cent), 17 (3 per cent), or 18 (2 per cent).

The rostral is usually wider than high (equal in 13 per cent) and is in contact with the prenasals, although in some cases the prenasals are sutured, thus starting the granules which are so characteristic of *mitchellii* and *pyrrhus*. The prenasals are normally in contact with the supralabials but such contact is prevented, in 17 per cent of the specimens examined, by the extension to the rostral of the small scales anterior to the pit; there is partial interference in an additional 4 per cent. The internasals (scales in contact with the rostral between the nasals, regardless of size or relative position) usually number two; owing to the splitting

off of upper corners of the prenasals there is one instance of three and another of four; this out of a total of 60 specimens.

The scales on the crown anterior to the supraoculars vary from 13 to 38 and average 25.3. The minimum scale rows between supraoculars vary from 3 to 8, interquartile range 4.9 to 6.1; the average is 5.5

Supraocular sutures are highly characteristic of this subspecies; they are present in 96 per cent of the specimens. These sutures are of considerable variety; often they are whorls or longitudinal cuts, particularly at the outer edge. Sometimes these edges are rough as if pieces of scale had been broken away (text fig. 2). The nasals are divided. The loreals vary from 1 to 5, averaging 1.98; there are two in 41 per cent of the specimens, one in 37 per cent, and greater numbers in 22 per cent. The scales along the canthus rostralis, from internasal to supraocular, usually number 3, sometimes 2 or 4.

The upper preocular is divided horizontally in 4 per cent, and vertically in 18 per cent of the specimens. This is a division which is still more evident in the other members of the *mitchellii* group.

The upper preocular, which is the larger, is not in contact with the postnasal. In 46 per cent such contact is prevented by the contact of the postcanthal with the loreal, in 54 per cent by the presence of a small upper loreal.

The scale rows from labials to orbit usually number 2 or 3. Generally the third and fourth, or fourth and fifth supralabials are in contact with the pit borders; there is no conspicuous difference in size amongst the supralabials.

The first infralabials are undivided. The mental is triangular. The genials are in a single pair, relatively short and obtuse. Intergenials are present in 4 per cent of the specimens; submentals are not in evidence.

In shape the head is subtriangular, flat-topped and low. The average ratio of body length to head length in adults is 22.8.

The ratio of the length of tail to total length, exclusive of rattle, averages 0.079 in adult males and 0.059 in females.

The largest specimen examined measured 885 mm. (35 in.), the smallest 257 mm. (10 in.). A specimen 860 mm. long weighed 376 grams. The smallest female with eggs measured 674 mm.

Color and Pattern.—This subspecies is highly variable in color and pattern, as if the several desert mountain ranges which it inhabits had produced individual races. The ground color may be straw, tan, buff, yellow-brown, red-brown, gray, or blue-gray. Upon this there is superimposed a series of darker dorsal blotches which, while usually subhexagonal in shape, may approach circles, diamonds, squares, or rectangles. They are buff, gray, brown, or deep red-brown, and may, or may not, be sharply contrasting with the ground color. Some of the contrasts and harmonies, particularly in the browns, are very striking, rendering this one of the handsomest of rattlesnakes, exceeded only by *enyo* and *molossus*.

There is a secondary series of blotches on the sides; at about mid-body the main dorsal series contacts these so as to form rings, which become narrower and less sharply in contrast with the ground color toward the tail. At the neck several dorsal blotches may coalesce to form a longitudinal band. The inter-blotch areas are lighter dorsally than laterally. Anteriorly the sides are often suffused with a

punctated application of gray (even on the brown specimens), a character found in *pyrrhus* as well. The dorsal blotches are sometimes even-edged, but are more often serrated by a border of unicolor scales in the manner of *scutulatus*. Sometimes the light scales bordering the blotches are conspicuously lighter than the rest of the ground color. Often the light scales, immediately anterior to the blotches, are posteriorly tipped with black; this is, in fact, quite characteristic of the present subspecies.

Northern specimens are darker and more conspicuously and definitely marked than those from the south; the latter more nearly approach the amorphous punctations of *pyrrhus*. Red-brown or dark-brown specimens are the rule from the northwestern corner of the range in the vicinity of Bishop Creek, California. In the northeastern corner, in Nevada, blues and grays predominate. The southeastern specimens are generally tan, blotched with brown.

The ventral surface is usually buff or tan, with aggregations of darker punctations.

The head is spotted, but less conspicuously and regularly than the body. Supraocular light cross-marks are usually absent, but the outer edge of each supraocular may be light. There is often a dark dash from the eye to a point above the corner of the mouth, but in many specimens this is obscured by a characteristic suffusion of gray, which, in the tan or brown specimens, is in rather sharp contrast with the dorsal color.

The tail rings are usually distinct, but the last two or three, which are generally black and in strong color contrast with the rest of the body, are not evenly outlined, and may be partly confluent.

The body blotches vary in number from 30 to 43, the average being 37.0. The tail rings number 6 to 9 (average 6.8) in the males, and 3 to 6 (average 4.6) in the females.

CHARACTER SUMMARIES

Having presented separately, for each of the three subspecies of *mitchellii*, the essential details of lepidosis, form, and appearance, I deem it desirable to combine the enumerations of other characteristics, in order to avoid repetition under each subspecies, since the differences between the three forms are not considerable.

Habitat.—All three subspecies of *mitchellii* are essentially rock-dwelling snakes, and to a large extent, but not entirely, are restricted to the wastes of the southwestern deserts. Here, however, they are not universally distributed; from the level, sandy plains and the great alluvial fans they are generally absent, their habitat being in the rocky mountains and buttes which rise above the plains. Thus, while the range of *mitchellii* is roughly coincident with those of *C. cerastes*, *C. scutulatus*, and *C. atrox* in parts of Arizona and California, they are not particularly active competitors, for locally there is often a rather sharp distinction in the habitat which each species prefers.

For example, in the Panamint and Death Valley regions we find *stephensi* in the lava flows, rocky buttes, and the mountains themselves (to altitudes of at least 7000 ft.) rather than in the plains between, the latter being inhabited by *cerastes*. In the Mohave Desert we find *cerastes* and *scutulatus* on the flats,

and *pyrrhus* in the mountains, and the same is true in southwestern Arizona where *atrox* is included with the plains species. From the Imperial and Coachella Valleys *pyrrhus* seems absent, although present in all the surrounding mountains.

In the Peninsula ranges of southern and Lower California, including the San Bernardinos, San Jacintos, Cuyamacas, Sierra de Juarez, and Sierra San Pedro Mártir, we find *pyrrhus* ranging into Upper Sonoran habitats and even touching Transition. Yet, in the chaparral and oaks, it continues to show its preference for rocky outcrops, although not restricted to them. Here it reaches altitudes of at least 5300 ft. in areas shared with *Crotalus ruber* and *C. c. oreganus*. But while the latter are equally common westward to the ocean, *pyrrhus* rarely is found below the 1200 ft. contour on the coastal slope.

It is in these mountains also that *mitchellii*, in the subspecies *pyrrhus*, reaches its maximum mainland size, specimens slightly exceeding 1220 mm. (48 in.) having been accurately measured. Such an individual would weight about 2½ lb. (1130 g.). This size is not approached by either *stephensi* or *m. mitchellii*.[13] These, of course, are exceptional specimens; I would consider 1100 mm. (43 in.) as representing a "large" adult male *pyrrhus* in the foothills of San Diego County. In Arizona and, in fact, throughout the truly desert areas, this size is not reached, few adults exceeding 920 mm. (36 in.). The Angel de la Guarda Island specimens are very large, reaching at least 1240 mm. (49 in.). *Stephensi* is a smaller snake than *pyrrhus*, specimens exceeding 850 mm. (33½ in.) being exceptional. *M. mitchellii*, while smaller than *pyrrhus*, sometimes exceeds 900 mm. (35 in.) and one specimen 939 mm. (39 in.) has been noted. However, most of the adult males run about 850 mm. (33½ in.) in length.

From a few areas we have some statistics as to the relative frequency of occurrence of *mitchellii* compared with the other species with which it shares the range. Thus, in four lots of rattlers brought up from the vicinity of Cape San Lucas there were 69 *m. mitchellii* or 17.6 per cent, out of a total of 391 rattlers; 6.4 per cent were *enyo*, the rest being *lucasensis*.

In San Diego County, out of 2006 rattlesnakes recorded, only 260 or 12.6 per cent were *pyrrhus*, for this form was greatly exceeded in number by *ruber* and *oreganus*.

Along the line of the Santa Fe Ry. between Hillside and Wickenburg, Yavapai County, Arizona, a collection of 454 rattlers yielded 19 *pyrrhus* or 4.2 per cent. The majority were *atrox* and *scutulatus* (55.6 and 31.9 per cent) with a few *molossus* and *oreganus* (4.6 and 3.7 per cent). Since these specimens were collected by track maintenance crews it is to be expected that the rock inhabiting forms would not be as well represented as those preferring the flat-lands.

Thus, it is seen that where *mitchellii* is in competition with other forms it usually constitutes only a small part of the rattlesnake population. Several species of rattlers occur in most of the territory inhabited by *pyrrhus* and *mitchellii*

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[13] A specimen (USNM 64588) 1295 mm. (51 in.) long is contained in the National Museum. The locality of collection is uncertain, but it is recorded tentatively as Cedros Island. This I rather doubt, since subsequent collectors have failed to find it there, although other rattlers (*C. exsul*) are not uncommon.

although they may have the rocky prominences to themselves. *Stephensi*, on the other hand, is the sole possessor of most of its range, or, at least, shares it only with *cerastes*, with which it is hardly in competition, so clearly does the one prefer valleys and sand, and the other rocky slopes and mountains.

There is evidence that where *mitchellii* shares its territory with others it does not den with them. Thus, a reliable observer reported having seen some twenty *pyrrhus* in a shallow cave under a large granite boulder in San Diego County; there seemed to be no other rattlers present, although both *ruber* and *oreganus* are more common than *pyrrhus* in that particular place. In another instance, in December, nine rattlers were found under a single stone; all were young adult *pyrrhus*.

Breeding.—Specimens of *stephensi* have been noted with 6 and 8 eggs; *pyrrhus* with 3, 4 (2 specimens), and 5. Experience with other species leads us to believe that these *pyrrhus* broods were smaller than the average for the species.

Habits.—In the field *pyrrhus* is a distinctly more nervous species than *ruber;* rather it resembles *oreganus* in its alert readiness to defend itself or escape. It will usually rattle if alarmed. Mrs. G. O. Wiley, however, reports it as easily tamed as other species, if not more so.

As is the case with most of the western rattlers, particularly the desert forms, *mitchellii* is largely nocturnal, especially in summer. However, it will be found abroad in the daytime in spring, and to a less extent in autumn. Thus, a specimen of *stephensi* was seen to issue from a hole at 6:30 p. m., in August. In late March specimens were observed crossing the road at Bullfrog, Nevada, at 3:00 p. m., and near Ballarat, at 6:25 p. m. In the spring, in San Diego County, specimens of *pyrrhus* have been observed sunning themselves before rock clefts in which they took refuge so promptly as to indicate advance consideration of these retreats.

Food.—The snakes of the *mitchellii* group, as is usual with the larger rattlesnakes, subsist principally upon rats, mice, and other small mammals. Amongst these, *Dipodomys* has been recognized. Young specimens are probably more accustomed to lizards, and even the adults do not scorn this prey. Amongst the species noted in the stomach contents were *Uta stansburiana, Cnemidophorus tessellatus,* and *Eumeces skiltonianus*. One large specimen contained both mammal hair and a *Uta*. One large *mitchellii* was observed to eat a ground squirrel which had been shot some three hours before.

Birds are eaten occasionally. Thus Mr. Dean E. Batchelder informed me he had found 8 birds, presumably goldfinches, in the stomach of a *pyrrhus*. All had been swallowed head first. This was near an aqueduct construction camp where a lawn, garden, and bird bath had been installed on the desert 10 miles north of Desert Center, Riverside Co., Calif. Birds had been attracted from great distances and evidently the snake had lain in wait for them.

Hemipenes.—The hemipenes of the *mitchellii* group may be described thus: Completely bifurcate with divided sulcus. Base covered with short, stiff spines, particularly at the outer shoulders; the branches covered with reticulate fringes. There is a sharp cleavage between spines and fringes (a characteristic of *Crotalus* as compared with *Sistrurus,* with the partial exception of *C. lepidus*). The apices are calyculate. In shape the two lobes are of medium weight (ratio of length to diameter about 2.6) similar to the *confluentus* group; this is in contrast to the

attenuated organs which characterize the *atrox* group, or the opposite extreme, illustrated by the short heavy lobes of *molossus*. The spines cannot be counted with accuracy, since they vary by imperceptible degrees from mere pustules to full points. The fringes vary from 27 to 34, averaging about 31.

One of the important variations in the hemipenes of *Crotalus* is the presence or absence of spines in the crotch between the lobes. These spines are present in all subspecies of *mitchellii*. They are especially conspicuous in *mitchellii mitchellii* and *stephensi*, somewhat less so in the intermediate specimens (*pyrrhus*) from California, and are least perceptible in *pyrrhus* from Arizona.

Fangs.—The fangs of *mitchellii*, in shape and size, follow closely the *confluentus* group, that is, they are shorter proportionately than those of *terrificus, adamanteus*, and the *atrox* group. Average adult ratios of body and head length to fang length (measured from the lower edge of the upper lumen to the tip) are as follows:

FANG LENGTH RATIOS

	L/F	*H/F*
Mitchellii	151	5.74
Pyrrhus	107	5.01
Stephensi	128	5.59

Here again we have a substantial difference between *mitchellii* and *pyrrhus*, although one which is obviously correlated with proportionate head size.

Venom.—The physical characters of the venoms of these three subspecies are indicated in the following table:

VENOM CHARACTERISTICS

	Mitchellii	*Pyrrhus*	*Stephensi*
Specimens milked	64	298	13
Average yield dry venom per adult snake, mg.	33	215	73
Maximum yield, mg.	75	350	129
Specific gravity	1.078	1.090	1.088
Average MLD	0.04?	0.50	0.20

The MLD is taken from data kindly furnished by Dr. Thos. S. Githens of the Mulford Biological Laboratories of Sharp and Dohme, and represents the fatal dose for a pigeon of 350 g. weight. From results in other species we would expect *mitchellii*, with its small head and short fangs, to have a relatively powerful venom, as compared with *pyrrhus*.[14]

Rattles.—Studies, as yet unpublished, indicate that the characteristics, and

[14] Githens (Journal of Immunology, Vol. 29, p. 171, Aug. 1935) reports two qualities of *mitchellii* venom: a "strong" with an MLD of 0.04 and a "weak" with an MLD of 0.50. The venoms which yielded these results were sent to the biological laboratory from San Diego. Through correspondence with Dr. Githens I have ascertained the lot numbers involved in the several assays and checking the original data I find that three assays yielding an average MLD of 0.50 contained only *pyrrhus* venom. One assay resulting in an MLD of 0.04 was based exclusively on *mitchellii* venom. Only one assay tends in any way to upset the theory that the venoms of *pyrrhus* and *mitchellii* differ considerably, the latter being the more toxic. This assay, on a mixture of *mitchellii* and *pyrrhus* venoms sent in before the subspecies were distinguished, also yielded an MLD of 0.04, whereas some figure between the two might have been expected. I am unable to explain this unless the more powerful venom tends to mask the weaker.

particularly certain measurements, of the rattles, are of considerable interest in classification. These dimensions are found to be quite consistent, and from them it is possible to verify relationships and differences. As an instance, the width of each rattle (where the string is complete and the rattle-number in the sequence is therefore known) is found of value in classification. In the present study we have the following data:

Average Width of Rattle in Tenths of Millimeters

Rattle No.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Mitchellii	82	99	111	127	136	144	148	147	146
Pyrrhus (Cal.)	70	83	96	109	122	131	128	139	138
Pyrrhus (Ariz.)	62	76	91	103	111	120	136	138	140
Stephensi	48	61	75	103	112	116			

The figures are not particularly trustworthy beyond the fifth rattle for two reasons; first, a sufficient number of specimens is not available to afford accurate averages; and, secondly, sexual dimorphism begins to affect the result beyond the sixth rattle, and therefore for accuracy of diagnosis it is necessary to treat the sexes separately. However up to the sixth rattle, except in the case of *stephensi*, of which comparatively few specimens, even of the first rattles, are available, the figures are quite reliable. These studies, to be presented elsewhere, show that, within geographically homogeneous groups, the coefficient of variation of the rattle widths of the first five rattles usually runs from 5 to 7 per cent and rarely exceeds 9 per cent. Under such circumstances differences such as those indicated in these tables, particularly between *mitchellii* and *pyrrhus*, can be shown mathematically to be highly significant.[15]

While it is not believed advisable to attempt any species differentiation exclusively based on rattle divergences, these certainly should not be neglected as confirmatory evidence.

RELATIONSHIPS AND DIFFERENCES

As I have stated before, *mitchellii* cannot always be distinguished from the other rattlesnakes by its best known character, namely, the separation of the rostral from the prenasals by small scales or granules; for this character is not universally positive in either of the southern races, *m. mitchellii* and *pyrrhus*, and it is always negative in *stephensi*. Furthermore, this prevention of contact is of sporadic occurrence in other forms, particularly in *oreganus* from central Arizona. Nor is the depression of the head, while somewhat evident, the clear-cut and obvious character which it has been occasionally considered in the past. The same is true of the shape of the rostral, which is not always wider than high.

In general, it can be said that these snakes are conspicuous amongst the rattlesnakes for the tendency to subdivision of certain head scales (prenasals, canthals, loreals, and preoculars in *mitchellii* and *pyrrhus;* and supraoculars in *stephensi*), and for the punctated application of color and pattern. Yet there is sufficient variation and divergence in all of these characters so that simple and invariable keys are impossible; therefore, considerable judgment and some experi-

[15] Employing the usual formula for significance by evaluating the ratio which the difference between the means bears to the standard error of the difference.

ence are necessary in their application if errors are not to be made. However I do not think that this is an adverse criterion of the validity of these forms, since the summation of the differences is impressive; and some differences which are not particularly useful as key characters, such as the form of the hemipenes, nevertheless are important in the final determination of validity.

The nearest existing relatives to *mitchellii* are *tigris, cerastes,* and *confluentus* (the latter through the subspecies *oreganus* and *lutosus*), probably in the order named. These affinities are shown in form, scalation, pattern, and hemipenes, as will be pointed out.

The characters of lepidosis which are usually employed statistically in distinguishing species of snakes, are not of particular value in separating the members of the *mitchellii* group, either from each other or from some of their near relations, for a number of rattlers, including the several subspecies of *confluentus* and *mitchellii,* as well as *scutulatus* and *tigris* do not differ greatly in these characters. However, a few tendencies are to be noted.

In scale rows, 25 is the mode in *m. mitchellii* and *pyrrhus,* but this is reduced to 23 in *stephensi,* which, in this particular, resembles *tigris.* About half of the Arizona specimens of *pyrrhus* have 23 scale rows, a much higher percentage than is encountered in the California specimens.

Mitchellii is a rough-scaled species, the dorsal scales being sharply ridged and with raised bosses posterior to the middle of each scale. The latter are more conspicuous in *mitchellii mitchellii,* and in southern California *pyrrhus,* than in *pyrrhus* from Arizona or *stephensi.* However, in none of these snakes are the bosses so extreme as in *cerastes,* which is outstanding in this character amongst our southwestern rattlers; and even this form is exceeded in the prominence of these dorsal scale protuberances by *durissus.* The extreme spinal ridge of *durissus* is also absent in *mitchellii, enyo* most nearly approaching the tropical rattler in this character.

In ventrals *mitchellii* and Arizona *pyrrhus* average slightly lower than California *pyrrhus,* but the difference is not conspicuous; *stephensi* is also low. In this character *tigris* is conspicuously different from *stephensi,* as set forth in the following table:

AVERAGE VENTRAL SCALE COUNTS

	Males	*Females*
Mitchellii	176.7	179.5
Pyrrhus (Southern California)	178.3	180.0
Pyrrhus (Arizona)	174.4	175.4
Stephensi	174.4	178.7
Tigris	165.2	168.5

The extent of the difference between *stephensi* and *tigris,* as indicated by the ratio of the difference between the means to the standard error of the difference, is 9.2 for the males and 9.3 for the females. In calculations of this kind any ratio above 3 is usually considered significant; 9 may be taken as conclusive on this point, that is to say the difference is real and cannot be attributed to chance differences in sampling. The differences in caudal scale counts are not important; *stephensi* and *mitchellii* are slightly higher than *pyrrhus.*

It is interesting to note that there is less sexual dimorphism in ventral scales

in *mitchellii* than is apparent in most rattlesnake species. In the *mitchellii* subspecies the females average about 3 more ventrals than the males; the *confluentus* group and many other rattlers run from 4 to 7.

In labial counts we find *pyrrhus* somewhat higher than *mitchellii,* which, in turn, exceeds *stephensi.* None of the differences is sufficient to be of interest as a key character.

Divided first infralabials are quite characteristic of Arizona *pyrrhus,* being present in 70 per cent of the specimens; in California *pyrrhus* they are frequent in San Bernardino County but are rarely met with elsewhere in the range of *pyrrhus,* or in *mitchellii* or *stephensi.* Intergenials and submentals are occasionally noted, but are not characteristic of any of these forms.

Of the other head scales, such as the internasals, canthals, inter-supraoculars (frontals), nasals, loreals, and oculars, whose numbers, contacts, and arrangements are so frequently of value in rattlesnake diagnosis, we can in the *mitchellii* group make little use because of their tendency to be split to such a degree that their classification becomes impossible. For instance, where there is so frequently a row of scales between prenasal and rostral (as in *mitchellii* and *pyrrhus*) the internasals are indeterminate; canthals and loreals cannot be separated; preoculars are broken vertically, horizontally, or both (text fig. 1), and thus are confused with loreals. But a few differences of importance may be noted in these scales which may be summarized as follows:

1. Supraocular sutures (text fig. 2) are highly characteristic of *stephensi* and will serve to differentiate this form from *tigris,* and, to a lesser extent from *lutosus.* Stated statistically we have the following:

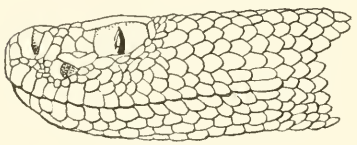

Fig. 1

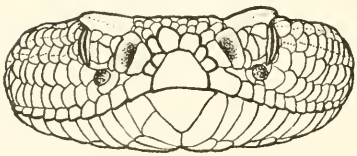

Fig. 3

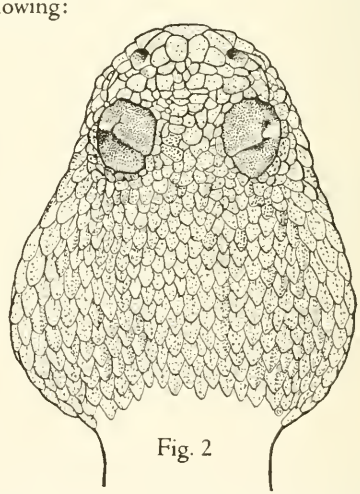

Fig. 2

Fig. 1. *Crotalus mitchellii mitchellii.* Lateral view of head showing subdivision of preoculars, loreals, and supralabials.

Fig. 2. *Crotalus mitchellii stephensi.* Dorsal view of head showing supraocular sutures.

Fig. 3. *Crotalus mitchellii pyrrhus.* End view of head showing absence of contact between rostral and prenasals.

SUPRAOCULAR SUTURES
(two counts per specimen)

	With Sutures	*Without Sutures*	*Doubtful*
Stephensi	120	2	2
Tigris	0	82	2
Lutosus (Cal. and Nev. only)	26	168	4

Supraocular sutures are not infrequent in *mitchellii* and *pyrrhus;* they are quite prevalent in specimens from northern Baja California.

2. Internasals are determinate in *stephensi* and will distinguish this form from *lutosus*. Thus in 60 specimens of *stephensi*, one had 3 and one had 4 internasals; all others had 2. On the other hand, in 103 specimens of *lutosus* from California and Nevada there were only 4 specimens with less than 3 internasals, the complete score being as follows (the first number indicating the number of internasals, the second the number of individuals): 1/1, 2/3, 3/28, 4/62, 5/6, 6/3. Only California and Nevada specimens of *lutosus* were used in this comparison, instead of snakes from all areas, upon the theory that the former, occupying a territory close to that of *stephensi*, are the ones most necessary to differentiate from *stephensi*. It may be of interest to note that the two aberrant specimens of *stephensi* (having more than two internasals) are from near *pyrrhus* territory and have an increased number of internasals by reason of the splitting of the prenasals (a characteristic of *pyrrhus*), rather than of the internasals themselves, as in *lutosus* and all the *confluentus* group.

3. The rostral-prenasal interruption (text fig. 3), while not a universal key character to *mitchellii* and *pyrrhus* as was once supposed, is, nevertheless, usually indicative. Thus, it is positive in 97 per cent of *mitchellii*, and about 88 per cent of *pyrrhus*. Most of the aberrant specimens of *pyrrhus* occur in southern California, approaching the territory of *stephensi;* this is to be expected in view of the intergradation of the two forms. In *stephensi* there are no cases of the failure of the rostral prenasal contact, and the same is true of *tigris*. The interruption of this contact, thus shown to be characteristic (but not universally so) of *mitchellii* and *pyrrhus*, does occur in some other species, particularly the subspecies of *confluentus;* it is most prevalent in *oreganus* from central Arizona, where about 12 per cent of the specimens have this contact interrupted. Lack of contact has also been observed in *abyssus* and in California *oreganus*.

4. It is characteristic of all the *mitchellii* subspecies and *tigris* that the rostral is wider than high; the contrary is usually true in all the *confluentus* subspecies. However, the two dimensions are not infrequently equal, especially in specimens of *pyrrhus* from southern California, so that at best this is but a confirmatory character. Occasionally specimens of *pyrrhus* have the rostral higher than wide.

The great variability in pattern and color of all subspecies of *mitchellii* renders these characteristics of little use in classification. Outstanding are the punctulate application of color in *mitchellii* and *pyrrhus* and the indefiniteness of the pattern; the gray suffusions on the lateral areas of *stephensi* and northern *pyrrhus;* the black posterior scale tips in many *stephensi* and some *pyrrhus;* the *scutulatus*

type of tail rings in many specimens of *pyrrhus* and *mitchellii*. But none of these characters is the sole possession of *mitchellii* subspecies; even the punctations are seen to be highly developed in *tigris, atrox* (although in a different manner), *confluentus* from New Mexico (Cope's *pulverulentus*), *triseriatus*, and others.

In number of body blotches and tail rings both *pyrrhus* and *mitchellii* fall below *stephensi*, and this, in turn, below *tigris*. However, the dispersion of these characters is so great that they are not useful as keys.

Coming now to form, we observe that *pyrrhus* is a somewhat heavier bodied snake than the other two subspecies. Proportionately it has a slightly shorter tail than either *mitchellii* or *stephensi*. But none of these is conspicuously different from the *atrox* or *confluentus* groups.

It is in head size that really important differences amongst the *mitchellii* subspecies are evident; here we have probably the most essential divergence between *mitchellii* and *pyrrhus*, and this in a character which must be presumed to be relatively stable.

The determination of the statistical significance of differences in such a character as the ratio of the head to body length is a somewhat involved problem. Such an investigation has been made, but its exposition would be out of place at this point, and is reserved for future publication. The conclusions concerning rattlesnakes may be summarized as follows:

1. The relationship of the size of the head to the body conforms closely to a linear equation of the form $H = a\,L + b$, the constants a and b being different for each of the several species or subspecies.

2. Owing to the presence of the constant term b in the regression equation, the ratio of body length to head length is not constant throughout life; young rattlesnakes have proportionately larger heads than adults.

3. There is a close correlation between head and body size in any one form, the coefficient of correlation probably being about +0.85 to 0.90. The dispersion about the regression line approximates the normal curve of error. The dispersion remains nearly proportional throughout life, although increasing slightly with age. The coefficient of variation about the regression line is from 2.5 to 3.5 per cent in homogeneous groups.

To simplify the problem in the present instance we can restrict our investigation to adult groups of approximately the same body size; if this be done the constant term b may be neglected, since the ratio L/H will be practically constant for each subspecies in any short length-range. The results of such a study of restricted adult groups are as follows, all specimens having been measured under the same conditions of preservation:

ADULT HEAD-LENGTH RATIOS

	Number of Specimens	*Length Range mm.*	*Length Average mm.*	*Head Length Average mm.*	*Ratio L/H*
Mitchellii	46	725–915	784	31.9	24.6
Pyrrhus (Calif.)	41	720–932	815	37.9	21.5
Pyrrhus (Ariz.)	14	700–895	775	35.9	21.6
Stephensi	20	720–872	783	34.4	22.8
Tigris	22	577–770	673	26.4	25.6

Thus it is seen that there is an essential difference in this character (which our investigations lead us to consider stable and consistent) between *pyrrhus* and *mitchellii,* and between *stephensi* and *tigris.* It will be noted that the average size of the specimens of *mitchellii* is slightly less than the average for California *pyrrhus,* and the *tigris* average is less than *stephensi.* Since L/H increases with growth, if the average length were the same in the two cases the differences in the L/H ratios would be slightly greater than is shown in the table.

As a further proof of the difference between *mitchellii* and *pyrrhus* the regression lines for the L—H relationships were determined; all specimens were reduced to the same standard body size and the hypothetical head length for each specimen was calculated on the assumption that the deviation of any individual from the regression line for that subspecies remains constant (in percentage) throughout life. By this method it was determined that the ratio of the difference in the means of the head sizes to the standard error of the difference was over 17, which indicates that the difference is a real one and not attributable to the accidental composition of the group available for study (i. e., sampling errors). On the other hand between Arizona and California *pyrrhus* there was found to be no significant difference, the corresponding ratio being only 0.4.

Tigris has proportionately the smallest head amongst all the rattlesnakes; it is of interest to note that it is closely approached by *mitchellii;* on the other hand *pyrrhus* and *stephensi* approximate the rattlesnake mode in the body-head ratio.

That these differences in the head dimensions between *mitchellii* and *pyrrhus,* and between *stephensi* and *tigris* are not merely an exaggeration of a minor statistical deviation will be at once apparent to any one having the opportunity to compare adult specimens of these forms in life. It is to be remembered that there are proportionately similar differences in head width and in depth as well as in length; there is therefore a difference in bulk approximately equal to the cube of any linear dimension. The result is so striking that there is no difficulty in segregating these forms at a glance when adults of approximately the same body length are available.

As might be expected, fang length is closely correlated with head length[16] and thus the fangs repeat the differences observed in the ratio of head size to length of body overall. But here we find that the differences are even more impressive, for *tigris* and *mitchellii* not only have shorter fangs than *stephensi* and *pyrrhus* because of their smaller heads, but have, in fact, fangs which are disproportionately shorter even where snakes of the same head size are taken. With relation to the body lengths overall, the discrepancy is still greater. This is apparent from the following table showing data for the subspecies under consideration and their relatives:

AVERAGE FANG-LENGTH RATIOS

	L/F	*H/F*		*L/F*	*H/F*
Mitchellii	151	5.74	*Tigris*	165	6.11
Pyrrhus	107	5.01	*Lutosus*	131	5.49
Stephensi	128	5.59	*Cerastes*	98	4.83

(*L*=body-length overall; *H*=length of head; *F*=length of fang, upper lumen to point).

[16] The regression equation is of the form F=a H - b.

The resemblance of *mitchellii* to *tigris* rather than to *pyrrhus,* and of *stephensi* to *lutosus* rather than to *tigris* is at once evident.

Venom differences, at present imperfectly known, have already been set forth. I would anticipate that *mitchellii* would again show an affinity to *tigris* rather than *pyrrhus,* but its MLD has only been tentatively determined. Githens reports *tigris* venom to be the most toxic of any of the 22 subspecies of rattlers thus far investigated.

The study of the rattles of the rattlesnake, from the standpoint of species differences is so involved that publication of these data must be reserved for another place. Suffice it to say that *mitchellii* is well differentiated from *pyrrhus. Tigris* more nearly resembles *pyrrhus* than *stephensi. Mitchellii* has the largest rattles of any known rattlesnake, up to and including the fifth rattle, a most surprising fact in view of its relatively small size. It considerably exceeds its relative *pyrrhus* and is in fact approached most closely by *adamanteus* and *lucasensis.* The first of these being the largest of rattlesnakes, its possession of large rattles is not unexpected.

The hemipenial characteristics of the *mitchellii* group afford the clearest differentiation from the *confluentus* group, for although both of these have organs of somewhat the same ratio of lobe length to diameter (thus sharply different from the attenuated organs of the *atrox* group on the one hand and the globular habitus of *molossus* on the other) the *confluentus* group is without spines in the central crotch while these are always present in the *mitchellii* group. Here *pyrrhus* shows a closer affinity to *lutosus* and *oreganus* than do *mitchellii* or *stephensi,* for the latter have patches of spines in the cleft while in *pyrrhus* (especially those from Arizona) the spines in this area are usually few and not particularly large. In this character *tigris* resembles *stephensi; cerastes* also has a cleft-patch.

ISLAND SPECIMENS

The following Gulf of California island specimens are available for study:

Angel de la Guarda	5
San José	1
Espiritu Santo	3
Ceralvo	1

It is interesting to survey these for indications of incipient differentiation from the mainland forms, although there are not sufficient specimens upon which to premise descriptions of new species unless the differences be very wide.

First, we find, based on the most important difference (head proportion), between *mitchellii* and *pyrrhus,* that the Angel de la Guarda specimens are *pyrrhus,* while those from San José and Ceralvo are *mitchellii,* which is quite what would be expected geographically. The Espiritu Santo specimens are between the two mainland forms, although somewhat nearer *mitchellii* than *pyrrhus;* in rattle dimensions they are somewhat closer to the latter, but for the present we will consider them as *mitchellii.*

In ventrals the Angel de la Guarda specimens are distinctly higher than most of the specimens of *pyrrhus*, while those from the other islands have fewer scales than the average of *mitchellii*. There are indications that both differences would be significant, were enough specimens available to determine the dispersions of the island specimens more accurately. The caudals show no deviations of interest. The labials are rather low in the Angel de la Guarda specimens, and supraocular sutures are prevalent, showing in this last character an affinity for the specimens from the mountains of Lower California.

The Angel de la Guarda specimens are very large; they are pink or straw and usually have black scale tips; in color they resemble Arizona specimens rather than those from California. It is quite possible, I think, that USNM 64588, the largest known *pyrrhus*, may have come from Angel de la Guarda instead of Cedros Island, as has been presumed.[17]

The other island specimens are also pink, with the exception of that from Ceralvo, which is gray. We conclude that these island forms have been so long separated from the mainland that differentiation has begun, but it is not sufficient to permit taxonomic separation, at least not until much larger series are available.

It is unfortunate that the type specimen of *mitchellii* (USNM 5291½) has been lost and that Cope did not give the head measurement. He records this snake as being 44 in. (1118 mm.) long, which is so much larger than any other specimens from the Cape that we are disposed to doubt the accuracy of the locality. As was so often the case in those days the specimen was probably recorded from the locality from which it was sent, rather than the point of collection. The color and pattern descriptions also do not fit *mitchellii*.

We know from the tail length that the specimen was a male. The ventral scale count, given as 198, is so much higher than any other Cape male specimen (max. 181) that the specimen was either a freak or there has been a miscount. Calculations indicate an extremely small chance of such a high count, assuming that the dispersion follows the normal curve of error (which other studies indicate to be the case), for the deviation of this specimen is over six times the standard deviation. We conclude that the derivation of this specimen from Cape San Lucas is exceedingly doubtful, and if all the facts were known a shifting of names might be necessary.

CONCLUSIONS

Crotalus mitchellii is a valid species of rattlesnake containing three well differentiated subspecies. *C. m. mitchellii, C. m. pyrrhus*, and *C. m. stephensi*. Of other existing species their closest relatives are *C. tigris, C. cerastes, C. c. oreganus,* and *C. c. lutosus*. *C. m. mitchellii* shows an affinity to *tigris;* while *pyrrhus* and *stephensi* have important resemblances to *oreganus* and *lutosus*.

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[17] Schmidt, 1922, p. 700.

ACKNOWLEDGMENTS

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The following have presented me with live or preserved specimens which have been of the greatest service in this investigation: C. C. Lamb, J. R. Pemberton, Miss Ada Meling, the late A. H. Schlanze, Maj. Chapman Grant, Mrs. G. O. Wiley, A. P. Artran, C. M. Perkins, Chas. M. Bogert, L. H. Cook, T. C. Biggs, G. W. Kuns, M. E. Spivey, Thos. Fitzmorris, C. L. Evans, Dr. C. E. Burt, F. E. Walker, C. L. Davis, E. L. Bulpitt, H. K. Gloyd, P. M. Klauber, O. N. Arrington, A. N. Handley, R. R. Humphrey, Dr. E. H. Taylor, C. B. Perkins, Dr. C. T. Vorhies.

Of the utmost importance have been the specimens received from the Santa Fe Railway Company in central Arizona, and the live collection brought to the San Diego Zoological Society from the Cape region of Lower California by Fred Lewis of the Yacht *Stranger*. Without the latter large and uniform series the differences between *mitchellii* and *pyrrhus* would not have been so apparent.

I have been greatly assisted by Messrs. L. H. Cook, Robert Hoard, and P. M. Klauber in the making of scale counts, and by Mrs. Elizabeth Leslie and Miss Eileen Carmody in tabulations and computations. The sketches are by Mr. Norman Bilderback, and the map and photographs by Mr. L. C. Kobler.

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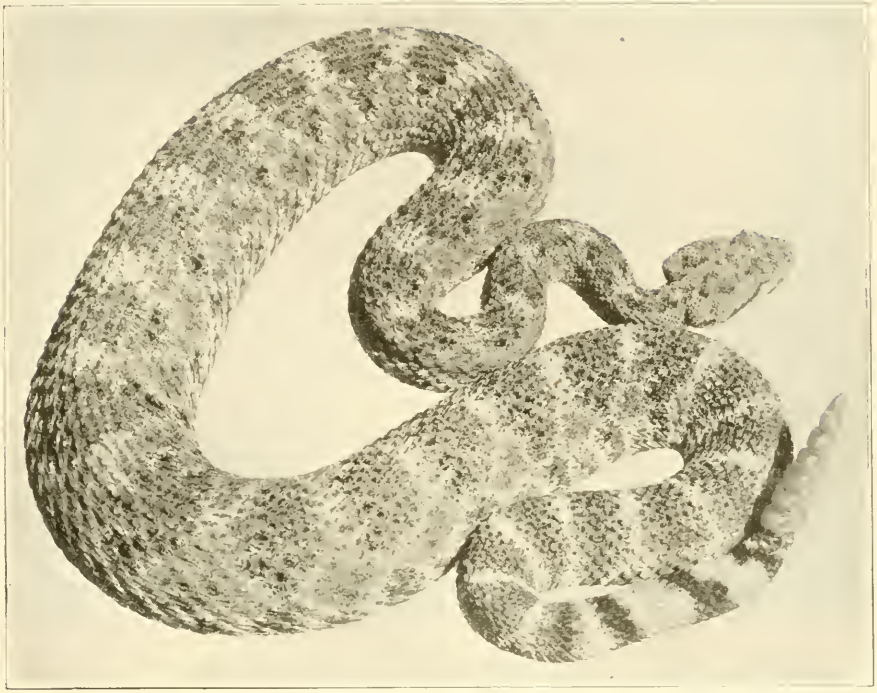

Fig. 1. *Crotalus mitchellii mitchellii.* San Lucan Speckled Rattlesnake. Adult male, collected at La Rivera, Baja California, by C. C. Lamb.

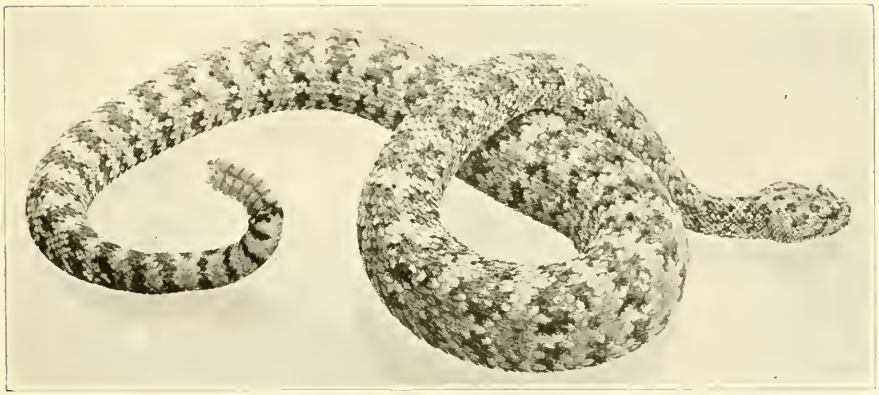

Fig. 2. *Crotalus mitchellii pyrrhus.* Southwestern Speckled Rattlesnake. Adult male, collected at Yaqui Well, San Diego County, California, by E. E. Benson.

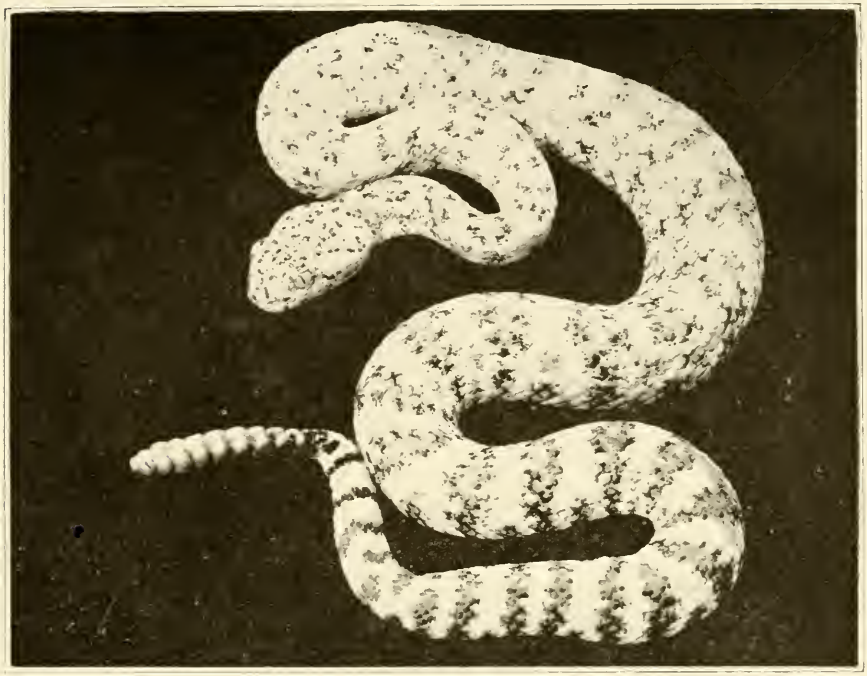

Fig. 1. *Crotalus mitchellii pyrrhus.* Southwestern Speckled Rattlesnake. Adult male, collected in Tinajas Altas Mts., Yuma Co., Arizona, by Dr. C. T. Vorhies.

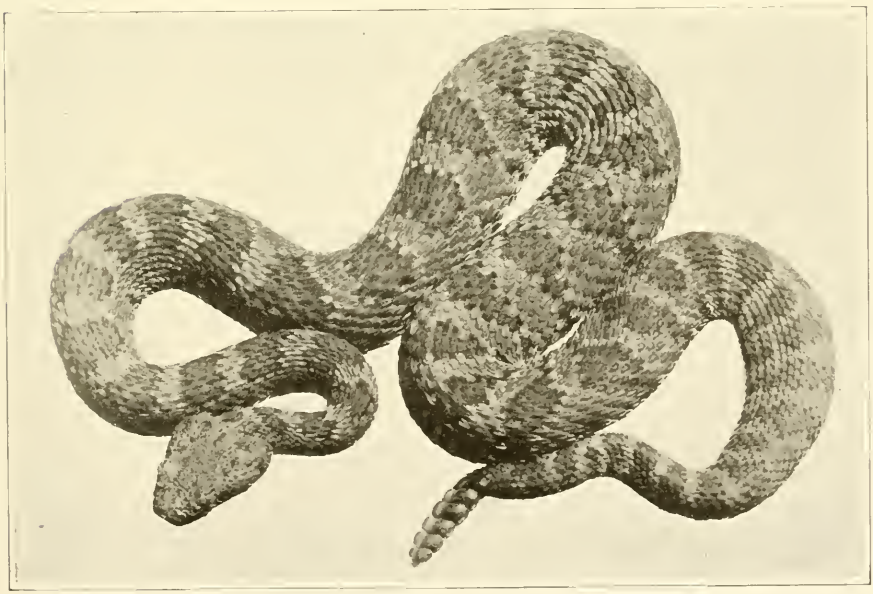

Fig. 2. *Crotalus mitchellii stephensi.* Panamint Rattlesnake. Adult male, collected 2 mi. S. of Aberdeen, Inyo Co., California, by F. E. Walker.

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TRANSACTIONS

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A KEY TO THE RATTLESNAKES WITH SUMMARY OF CHARACTERISTICS

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INTRODUCTION

The presentation of an identification key to the rattlesnakes appears desirable at this time since none is now available which incorporates the changes and additions resulting from recent taxonomic researches. The papers describing new subspecies are scattered in the literature and it would seem well to co-ordinate the results in a single publication in order that they will be more generally recognized by the nonspecialist in this field. Hence the publication of the key at this time, even though further changes resulting from investigations in taxonomy and nomenclature are to be expected in the future.

Recent researches in rattlesnake venoms have disclosed some rather surprising species differences both in toxicity and physiological effects. Differences in venom strength of an order of 60 to 1 have been indicated; and there appear to be differences in the relative proportions of hematoxins and neurotoxins. Under such circumstances, if our remedial technique is to be improved, it is important that species be differentiated in case reports. It is hoped that this key will serve a useful purpose in permitting physicians and others interested in the snake-bite problem to identify accurately the snake involved.

THE STATUS OF THE RATTLESNAKES

The following summary concerning the status of the rattlesnakes is presented to permit the non-herpetologist to orient himself with respect to the position of the group herein discussed.

Rattlesnakes comprise a number of species of venomous snakes belonging to the family *Crotalidae*. They are found only in the Western Hemisphere and reach their greatest profusion in the southwestern United States and northern Mexico. All rattlesnakes have at least one rattle* even when born, and the user of this key is presumed to be certain that he has a rattlesnake at hand, since the key is not intended to be of service in identifying other snakes, whether venomous or harmless.

Rattlesnakes and other members of the family *Crotalidae* are pit vipers, so called because of their possession of a sensory organ, probably auditory in purpose, in the form of a pit or deep depression, plainly visible on either side of the head below and back of the nostril (fig. 6).

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* Of course occasionally a rattlesnake may lose the end of his tail through accident and with it his identifying rattles, which thereafter will not be regenerated. But the tail will remain only as a stump; no sharp-tailed snake is a rattlesnake in disguise, as a surprising number of people seem to think possible.

In this the members of this family *(Crotalidae)* differ from the Old World vipers of the family *Viperidae,* sometimes called the true vipers, which do not possess pits. The true vipers and pit vipers have this in common: the venom fangs are seated in a rotatable bone (the maxillary) whereby when not in use they lie folded back against the roof of the mouth, from which position they may, at will, be rotated forward and downward into the biting position perpendicular to the upper jaw. There are many forms of dangerously venomous snakes which are not vipers, including the cobras, mambas, coral snakes, etc.; these have shorter, permanently erect fangs, at the front of the upper jaw.

By no means all of the members of the family *Crotalidae* are rattlesnakes. The pit vipers of this family are divided into the following genera, of which only the first two are rattlers:

GENUS	COMMON NAME	CHARACTERISTICS	HABITAT
Crotalus	Rattlesnakes	Possess rattles; scales on crown.	North & South America
Sistrurus	Ground Rattlesnakes	Possess rattles; plates on crown.	North America
Bothrops	Neotropical Pit Vipers	Without rattles; scales on crown; large posterior subcaudals.	North & South America
Lachesis	Bushmaster	Without rattles; scales on crown; small posterior subcaudals	Central & South America
Trimeresurus	Asiatic Pit Vipers	Without rattles; scales on crown.	Asia
Agkistrodon	Moccasins	Without rattles; plates on crown.	North America; SE. Europe; Asia

Some herpetologists, feeling that the genera *Bothrops* and *Trimeresurus* are insufficiently distinct to warrant separation, combine them under the latter name.

The rattlesnakes comprise the most important group of venomous snakes to be found in the United States. The only dangerously venomous snakes occurring in this territory *except rattlesnakes* are the following:

Micrurus fulvius fulvius (Linné), 1766.

Southeastern Coral Snake.

North Carolina to southern Florida; westward and southward along the Gulf lowlands into Mexico; northward in the Mississippi Valley to Ohio and Indiana.

Micrurus fulvius barbouri Schmidt, 1928.
South Florida Coral Snake.
Extreme southern Florida.
Micruroides euryxanthus (Kennicott), 1860.
Sonoran Coral Snake.
Southern border of Arizona and New Mexico, and south into Mexico.
Agkistrodon mokasen mokasen Beauvois, 1799.
Eastern Copperhead.
Massachusetts west to Illinois and from these south to northern Florida and eastern Texas, including the intervening states.
Agkistrodon mokasen laticinctus Gloyd and Conant, 1934.
Broad-banded Copperhead.
Western and central Oklahoma southward to western and central Texas.
Agkistrodon piscivorus (Lacépède), 1789.
Water Moccasin
Virginia south throughout Florida, westward along the Gulf to the Rio Grande and north in the Mississippi Valley to Illinois.

Thus it will be seen that there are found in the United States four species (six subspecies) of venomous snakes other than rattlesnakes. It is true that there are other, moderately venomous snakes in the southwest, including certain species of the genera *Leptodeira* and *Trimorphodon.* However it is doubtful whether the bite of one of these would be dangerous to a human being. The fangs are in the back of the mouth and are grooved rather than hollow; they are therefore not mechanically well-designed to inject venom into a wound in a large animal, although no doubt effective in subduing such small prey as lizards.

The copperheads and moccasins, being pit vipers, can be readily recognized by the presence of the pit and by their possession of rotatable fangs in the front of the upper jaw. These criteria will serve to distinguish them from various harmless snakes with which they are often confused, particularly certain water snakes of the genus *Natrix.* The coral snakes, small inoffensive-appearing creatures, may in their turn be recognized by the arrangement of the rings of their pattern. The coral snakes are ringed with black, red, and yellow; and it is characteristic of them that there is always a yellow ring between successive red and black rings. This is different from the color sequence in various harmless forms which are often taken for coral snakes, such as certain king snakes of the genus *Lampropeltis,* and other snakes of the genera *Rhinocheilus, Sonora, Chilomeniscus,* and *Cemophora.*

The above remarks on the recognition of dangerous snakes apply only to the United States. In Mexico, and more especially in Central and South America, there are many more species of venomous snakes other than rattlesnakes; for the latter do not occupy the dominant position there which they do in our country. As we go southward we encounter an increasingly complex variety of coral snakes *(Micrurus)* and a bewildering array (possibly 50 forms) of pit vipers of the genus *Bothrops,** to say

* One of the most important of these tropical pit vipers is the fer-de-lance, *Bothrops atrox,*

nothing of the bushmaster, *Lachesis muta,* and another moccasin, *Agkistrodon bilineatus.* Also in these areas various back-fanged snakes become so large that they may well be considered dangerous to man, although I have heard of no serious accidents from their bites. Thus it is not as simple, south of our borders, to determine which snakes are venomous and which harmless, although the pit vipers can still be recognized by their pits, and most of the coral snakes by the color arrangements of their patterns.

Having given this brief nontechnical survey of venomous snakes in the Americas other than rattlesnakes, we now return to the consideration of this group alone.

LIST OF SPECIES AND SUBSPECIES

In this key the following species and subspecies of rattlesnakes of the genera *Crotalus* and *Sistrurus* are recognized as valid:

1. *Crotalus durissus durissus* Linné, 1758.
   Central American Rattlesnake.
   Southern Mexico to Costa Rica.
2. *Crotalus durissus terrificus* (Laurenti), 1768.
   South American Rattlesnake.
   Costa Rica to Argentina.
3. *Crotalus unicolor* van Lidth de Jeude, 1887.
   Aruba Island Rattlesnake.
   Aruba Island, Dutch West Indies.
4. *Crotalus basiliscus* (Cope), 1864.
   Mexican West-Coast Rattlesnake.
   West Coast of Mexico from Sinaloa to Oaxaca.
5. *Crotalus enyo* (Cope), 1861.
   Lower California Rattlesnake.
   Central and southern Baja California.
6. *Crotalus molossus molossus* Baird and Girard, 1853.
   Northern Black-tailed Rattlesnake.
   West Texas to central Arizona and south to northern Durango.
7. *Crotalus molossus nigrescens* Gloyd, 1936.
   Southern Black-tailed Rattlesnake.
   Central Mexico from Durango to Puebla.
8. *Crotalus adamanteus* Beauvois, 1799.
   Eastern Diamond Rattlesnake.
   Coastal plains of the southeastern states.
9. *Crotalus cinereous* Le Conte in Hallowell, 1852.*
   Western Diamond Rattlesnake.
   Arkansas to southeastern California and south to San Luis Potosí.
10. *Crotalus tortugensis* Van Denburgh and Slevin, 1921.
    Tortuga Island Diamond Rattlesnake.
    Tortuga Island, Gulf of California.

* Previously known as *Crotalus atrox* Baird and Girard, 1853.

11. *Crotalus lucasensis* Van Denburgh, 1920.
    San Lucan Diamond Rattlesnake.
    Southern Baja California.
12. *Crotalus ruber* Cope, 1892.
    Red Diamond Rattlesnake.
    Coastal southern California, and northern and central Baja California.
13. *Crotalus exsul* Garman, 1883.
    Cedros Island Diamond Rattlesnake.
    Cedros Island off Baja California, Pacific side.
14. *Crotalus scutulatus* (Kennicott), 1861.
    Mohave Rattlesnake.
    Southeastern California to west Texas, and south to the central Mexican plateau.
15. *Crotalus viridis viridis* (Rafinesque), 1818.*
    Prairie Rattlesnake.
    Western Great Plains from Alberta and Saskatchewan to extreme northern Mexico.
16. *Crotalus viridis nuntius* Klauber, 1935.
    Arizona Prairie Rattlesnake.
    Northeastern Arizona.
17. *Crotalus viridis abyssus* Klauber, 1930.
    Grand Canyon Rattlesnake.
    Grand Canyon of Arizona.
18. *Crotalus viridis lutosus* Klauber, 1930.
    Great Basin Rattlesnake.
    The Great Basin between the Rockies and the Sierra Nevada.
19. *Crotalus viridis concolor* Woodbury, 1929.
    Midget Faded Rattlesnake.
    Eastern Utah and western Colorado.
20. *Crotalus viridis oreganus* Holbrook, 1840.
    Pacific Rattlesnake.
    Pacific Coast from British Columbia to central Baja California. Also Arizona.
21. *Crotalus mitchellii mitchellii* (Cope), 1861.
    San Lucan Speckled Rattlesnake.
    Southern half of Baja California.
22. *Crotalus mitchellii pyrrhus* (Cope), 1866.
    Southwestern Speckled Rattlesnake.
    Southern California, western Arizona, and northern Baja California.
23. *Crotalus mitchellii stephensi* Klauber, 1930.
    Panamint Rattlesnake.
    Southern Nevada and east-central California.

* Previously known as *Crotalus confluentus confluentus* Say, 1823.

24. *Crotalus tigris* Kennicott, 1859.
Tiger Rattlesnake.
Southern Arizona, and northern and central Sonora.

25. *Crotalus cerastes* Hallowell, 1854.
Horned Rattlesnake; Sidewinder.
Deserts of the southwestern United States and northwestern Mexico.

26. *Crotalus polystictus* (Cope), 1865.
Mexican Lance-headed Rattlesnake.
Tableland of central Mexico.

27. *Crotalus horridus horridus* Linné, 1758.
Timber Rattlesnake.
Eastern United States, Maine to Oklahoma.

28. *Crotalus horridus atricaudatus* Latreille, 1802.
Canebrake Rattlesnake.
Coastal plain of South Atlantic and Gulf states; lower Mississippi Valley.

29. *Crotalus lepidus lepidus* (Kennicott), 1861.
Eastern Rock Rattlesnake.
From west Texas south to northern San Luis Potosí.

30. *Crotalus lepidus klauberi* Gloyd, 1936.
Green Rock Rattlesnake.
Mountains of southern Arizona, southern New Mexico, and extreme west Texas south to Jalisco.

31. *Crotalus triseriatus triseriatus* Wagler, 1830.
Mexican Spotted Rattlesnake.
Central Mexican plateau.

32. *Crotalus triseriatus pricei* Van Denburgh, 1895.
Arizona Spotted Rattlesnake.
Southeastern Arizona to Durango.

33. *Crotalus stejnegeri* Dunn, 1919.
Long-tailed Rattlesnake.
Mountains of eastern Sinaloa and western Durango.

34. *Crotalus willardi* Meek, 1905.
Ridge-nosed Rattlesnake.
Southern Arizona to Zacatecas.

35. *Sistrurus ravus* (Cope), 1865.
Mexican Ground Rattlesnake.
Central Mexican plateau.

36. *Sistrurus miliarius miliarius* (Linné), 1766.
Carolina Ground Rattlesnake.
From North Carolina to central Alabama.

37. *Sistrurus miliarius barbouri* Gloyd, 1935.
Southeastern Ground Rattlesnake.
The Gulf lowlands from Georgia to Mississippi; Florida.

38. *Sistrurus miliarius streckeri* Gloyd, 1935.
Western Ground Rattlesnake.
Southern Missouri to Louisiana and west to central Texas.
39. *Sistrurus catenatus catenatus* (Rafinesque), 1818.
Eastern Massasauga.
Central New York west to eastern Oklahoma.
40. *Sistrurus catenatus tergeminus* (Say), 1823.
Western Massasauga.
Southwestern plains from central Kansas to northern Tamaulipas and southeastern Arizona.

While the ranges of the several forms are broadly indicated in the above table, more specific and detailed range limits will be found under each species or subspecies in the key itself. For page references to key characters and descriptions, and cross references to the appropriate maps and photographs of each species see the index.

VALIDITY

Decisions as to the validity of the several species and subspecies of rattlesnakes recognized are based on studies carried on by the writer during the past eight years. Scale counts and other data have been available on about 8000 specimens. All except four of the forms have been seen alive.

NOMENCLATURE

Although during the past two years I have given considerable time to a study of rattlesnake nomenclature, in the preparation of this key it was first decided to make no fundamental departures from current practice in the technical names employed, even though the validity of several might be questioned. It was feared that shifting some of the names long established in the literature might be a handicap to the adoption of the key, which I hoped would prove of practical value. Therefore the key first went to press with only minor changes in current usages.

But meanwhile I have had a further opportunity to discuss this phase of the situation with some of my herpetological friends. They have pointed out that as the key is presumed to clarify certain species differences, and as a long time must elapse before a second edition can be issued, such changes as are certain to be required eventually should be made at this time. To make the changes later, in a subsequent paper, would render the key obsolete only a short time after its issuance, and add to the confusion. This seems to be a logical view.

I know that to some these changes will appear a useless and over-technical imposition. But this is not hair-splitting nor the evidence of a contentious desire to disturb the peace. The changes will inevitably be made some day as studies of the species and literature continue, and "it is wiser for the present generation to bear with the temporary inconvenience of a few changes than to transmit to future generations our nomen-

clatorial problems, augmented a hundred fold by the addition of the ever-increasing number of systematic units made possible by the like increase in the amount of literature."*

The important changes from current usage which I find necessary are as follows: (1) substitute *Crotalus cinereous* Le Conte in Hallowell, 1852 for *Crotalus atrox* Baird and Girard, 1853; (2) substitute *Crotalus viridis* (Rafinesque), 1818 for *Crotalus confluentus* Say, 1823, affecting all the *confluentus* subspecies; (3) employ *Crotalus durissus* Linné, 1758 as the species name of the neotropical rattlesnake, relegating *terrificus* (Laurenti), 1768 to subspecific status as the name of the South American form; and finally (4) use *tergeminus* (Say), 1823 as the subspecific name of the western massasauga rather than *edwardsii* Baird and Girard, 1853.

The reasons which have dictated these decisions are summarized hereunder. I deem it undesirable at this time to give more than a brief outline of the factors involved, reserving for future publication a more complete exposition of these and other questions affecting rattlesnake nomenclature. It is not impossible that other changes will be found necessary as the work proceeds; and in any case it will be advisable to place on record the bases of decision where some currently used, but disputed names, have been retained.

(1) *Cinereous* antedates *atrox*. Although the description (Proc. Acad. Nat. Sci. Phila., Vol. 6, No. 5, pp. 177-182, 1852) is included under Hallowell's description of *Crotalus lecontei* (an invalid synonym of *Crotalus viridis*), nonetheless the description of *Crotalus cinereous,* as LeConte sent it to Hallowell, is printed in full in this publication. The snake which LeConte describes is not the same as Hallowell's *lecontei,* which the latter thought to be the case; on the contrary it is an excellent description of the western diamond rattlesnake and it was collected in an area (along the lower Colorado River†) where no other species could be confused with it. Opinion No. 4 of the Commission seems to be exactly in point: "Manuscript names acquire standing in nomenclature when printed in connection with the provisions of Art. 25, and the question as to their validity is not influenced by the fact whether such names are accepted or rejected by the author responsible for their publication."

(2) Rafinesque's description of his *Crotalinus viridis* (Am. Mon. Mag. and Crit. Rev., Vol. 4, No. 1, p. 41, Nov. 1818) leaves no question as to his meaning. The description, though brief, is clearly recognizable, especially when reinforced by the type locality. The upper Missouri

* International Commission on Zoological Nomenclature, Opinion No. 12, Smithsonian Special Publication No. 1938, p. 20, 1910.

† The description concludes with the words "Colorado, March, 1851" from which one might suppose that this specimen was taken in what is now the state of Colorado. But we know from LeConte's paper on Coleoptera in Ann. Lyc. Nat. Hist. N. Y., Vol. 5, pp. 125-216 at p. 125, that he was collecting along the Colorado River in Dec. 1850 and Mar. 1851, and in the valley of the Gila in Jan. and Feb. 1851. In assigning type localities to his insects he uses such terms as "Deserta fluminis Colorado; ad flumina Colorado et Gila, Martio; ad flumen Colorado circa millia XXX a mare;" or simply "Colorado." Thus it is clear that the type locality of *cinereous* is the Colorado Desert in the Yuma area. From the high dorsal and ventral scale counts we may even venture the guess that the specimen came from the California side of the river.

Valley is the center of population of the prairie rattlesnake; is was extremely plentiful in those days and, in fact, still is in many areas. No other rattler is found on the upper river. Two other rattlesnakes occur on the lower Missouri, the timber rattler and the massasauga, but we know that Rafinesque, in describing *viridis,* had neither of these in mind, for he described them as *C. cyanurus* and *C. catenatus,* respectively, in the same paper in which he described *viridis.*

(3) I have no desire at this time to revive the *horridus–durissus–terrificus–adamanteus* nomenclatorial discussion, always a fruitful source of argument. It is evident, however, that *durissus* Linné, 1758 must either take precedence over *terrificus* Laurenti, 1768 or it must fall entirely as unrecognizable; it is not a *nomen nudum* since a description is given and there was a type specimen, although it has been lost. Therefore it is either a species name or it should not be used at all; it cannot be revived with a date subsequent to 1758 to become a subspecies of *terrificus,* as has been done by some authors. For the present I retain *durissus* as the species name of the neotropical rattler, for while the caudal scale count (24) of the type seems low for this form, the black rhombs with light centers are characteristic of it over large areas in Mexico. This leaves *terrificus* as the South American subspecies.

(4) I prefer *tergeminus* to *edwardsii* as the name for the western massasauga, since I think it describes this rather than the eastern subspecies. I have discussed this with Mr. H. K. Gloyd, who has in preparation an extensive work on *Sistrurus* and we are in agreement on this point, which he will cover fully in one of his papers.

CONDENSED ALPHABETICAL SYNONYMY

In a work of this character it is impossible to include a synonymy under each species. The following condensed alphabetical list of synonyms is given in order that users of the key may ascertain the disposition which the present writer has made of the specific names hitherto proposed which he does not recognize as valid. The reasons dictating the decisions will be offered more fully in a subsequent publication.

In the case of each specific name only the intention of the original describer is considered; the shifts and reallocations made by subsequent authors, often giving the name a scope foreign to the purpose of the original describer, are omitted from presentation. Several species are listed which are not rattlesnakes but, being described under the genus *Crotalus,* are sometimes listed in synonymies of this genus.

Americana Catesby, 1743. Syn. *atricaudatus.* Pre-Linnean name without validity.

Atrox Baird and Girard, 1853. Syn. *cinereous.*

Boiquira Lacépède, 1789. Syn. *durissus.*

Cascavella Wagler in Spix, 1824. Syn. *terrificus.*

Catesbaei Fitzinger, 1826. Nomen nudum. Syn. *atricaudatus.* (Ex Hemprich, 1820?)

Cerberus Coues, 1875. Syn. *oreganus*. May later be recognized as a subspecies covering the southern half of the range of this form.
Collirhombeatus Amaral, 1926. Syn. *terrificus*.
Collilineatus Amaral, 1926. Syn. *terrificus*.
Concolor Jan, 1859. Nomen nudum. Not to be confused with *concolor* Woodbury, 1929, which is valid.
Confluentus Say, 1823. Syn. *viridis*.
Consors Baird and Girard, 1853. Syn. *tergeminus*.
Cumanensis Humboldt, 1833. Syn. *terrificus*.
Cyanurus Rafinesque, 1818. Syn. *horridus*.
Decolor Klauber, 1930. Syn. *concolor* Woodbury.
Dryinas Linné, 1758. Probably syn. *durissus*.
Edwardsii Baird and Girard, 1853. Syn. *tergeminus*.
Elegans Schmidt, 1922. Syn. *ruber*.
Exalbidus Boddaert, 1783. Syn. *durissus*.
Fasciatus Higgins, 1873. Composite syn. *horridus* and others.
Goldmani Schmidt, 1922. Syn. *pyrrhus*.
Gronovii Laurenti, 1768. Description too brief for recognition.
Hallowelli Cooper in Cronise, 1868. Nomen nudum.
Helleri Meek, 1905. Syn. *oreganus*.
Immaculatus Latreille, 1802. Probably syn. *durissus*.
Intermedius Troschel in Müller, 1865. Syn. *triseriatus*.
Intermedius Fischer, 1882. Syn. *triseriatus* besides being preoccupied by *intermedius* Troschel above.
Jimenezii Dugès, 1877. Syn. *polystictus*.
Kellyi Amaral, 1929. Syn. *scutulatus*.
Kirtlandi Holbrook, 1842. Syn. *catenatus*.
Lecontei Hallowell, 1852. Syn. *viridis*.
Loeflingii Humboldt, 1833. Syn. *terrificus*.
Lucifer Baird and Girard, 1852. Syn. *oreganus*.
Lugubris Jan, 1859. Composite syn. *triseriatus* and *polystictus*.
Melanurus Jan, 1859. Nomen nudum. Syn. *atricaudatus* by locality.
Messasaugus Kirtland, 1838. Syn. *catenatus*.
Mexicana Jan, 1863. Nomen nudum.
Minor Catesby, 1743. Syn. *miliarius*. Pre-Linnean name without validity.
Multimaculata Jan, 1863. Nomen nudum. Syn *polystictus* by figure published in 1874 but this was subsequent to description of *polystictus* Cope.
Mutus Linné, 1766. Not a rattlesnake.
Omiltemanus Günther, 1895. Syn. *triseriatus;* may have subspecific validity for extreme southern area where ventral scale counts are high.
Orientalis Laurenti, 1768. Description too brief for recognition; probably not a rattlesnake.
Ornatus Hallowell, 1854. Syn. *molossus*.
Pallidus Günther, 1895. Syn. *triseriatus*.

Table 1. Summary of Rattlesnake Characters

Species or Subspecies	Number of Specimens	Size*	Dorsal Scale Rows†	Ventral Scales		Subcaudal Scales		Supralabials	Infralabials	Scales Anterior to Supraoculars	Minimum Scales Between Supraoculars	Body Blotches	Tail Rings	
				Males	Females	Males	Females						Males	Females
C. durissus durissus	101	L	(25) 27—29—31	170—175—184‖	171—181—190‖	25—30—33	20—23—28	12—15—19	13—16—20	4— 6—11	2—2.4—5	20—25—32	7—8.6—10	5—6.3—8
C. durissus terrificus	42	L	(25) 27—29 (31)	166—170—178	171—178—180	22—28—31	20—22—24	11—14—17	14—15—18	4— 5— 9	1—2.3—4	19—24—28	4—6.1—8	3—4.5—6
C. unicolor	3	M	27	160—162—163	166	28	22	13	13	4	2	—	—	—
C. basiliscus	94	L	25—27—29	182‖—190—200	189‖—196—203	24—30—37	18—24—29	11—15—18	13—16—20	3— 5—10	2—2.8—5	26—33—41	5—8.7—11	4—6.7—9
C. enyo	61	M	23—25—27	159—164—168	161—169—177	22—25—28	18—19—23	12—13—15	11—14—16	11—18—30	2—4.2—6	28—35—42	3—6.0—8	4—4.6—7
C. molossus molossus	154	L	25—27—29	178—188—198	182—193—201	22—25—29	18—21—25	11—17—20	15—18—21	4— 7—16	2—2.7—7	20—32—40	*	*
C. molossus nigrescens	130	L	(23) 25—27	167—174—185	172—178—186	21—24—27	16—20—24	13—16—19	14—17—19	4— 6—10	2—2.1—5	17—28—34	*	*
C. adamanteus	45	L	27—29 (31)	165—171—175	174—178—182	27—30—32	22—24—26	12—14—16	15—18—21	10—21—33	4—6.2—8	26—30—34	5—6.9—10	3—4.3—6
C. cinereous	682	L	(23) 25—27 (29)	170—182—195	173—185—196	19—26—31	16—20—26	12—15—18	14—17—20	10—19—32	3—4.5—8	25—35—45	3—5.3—8	2—4.1—6
C. tortugensis	28	L	25—27	180—184—190	183—186—189	22—24—25	16—18—19	14—16—18	14—17—18	9—14—19	4—4.4—6	32—37—40	4—5.3—7	3—3.4—4
C. lucasensis	348	L	(25) 27—29 (31)	179—189—199	183—193—203	22—25—29	17—20—25	12—16—19	13—18—21	13—24—41	3—3.9—9	26—30—38	3—4.7—6	2—3.9—5
C. ruber	291	L	(25) 27—29—31	185—193—203	188—197—206	21—26—29	16—21—26	13—16—19	14—18—21	11—24—40	4—6.4—9	29—36—41	3—5.0—7	2—3.9—5
C. casul	22	M	27—29 (31)	188—191—195	192—194—196	18—22—26	17—19—23	11—17—19	15—17—19	17—24—40	6—7.7—9	30—32—35	3—4.1—5	3—3.7—4
C. scutulatus	393	L	(21) 23—25—27 (29)	166—178—190	167—181—192	21—25—29	15—19—25	12—15—18	12—16—18	6—11—21	1—2.1—5	27—36—44	3—5.0—8	2—3.7—6
C. viridis viridis	1886	L	(23) 25—27—29	164—178—189	170—185—196	21—26—31	14—20—26	10—15—18	11—16—19	8—22—45	1—3.3—7	33—43—55	6—9.8—15	4—7.4—11
C. viridis nuntius	190	M	(21) 23—25 (27)	163—171—181	169—177—182	21—25—28	14—19—22	12—15—17	12—15—19	12—21—42	2—3.6—8	33—42—53	5—9.5—12	5—7.1—10
C. viridis abyssus	32	M	(23) 25—27	173—178—185	179—184—191	21—25—29	18—20—23	13—16—18	14—16—18	23—34—18	4—6.6—8	38—42—48	7—8.2—12	6—6.9—8
C. viridis lutosus	394	L	23—25—27 (29)	171—179—189	174—184—196	18—23—29	13—19—25	12—15—19	13—16—19	11—31—50	3—6.5—10	32—40—49	5—7.1—10	4—5.8—8
C. viridis concolor	23	M	23—25 (27)	166—173—180	173—179—182	21—24—27	16—18—21	11—14—16	13—15—16	17—34—45	4—5.9—9	37—42—47	7—8.5—11	6—7.1—10
C. viridis oreganus	1394	L	23—25—27 (29)	158—171—190	165—178—194	18—24—29	15—19—26	11—15—18	13—16—20	7—25—50	2—5.0—9	23—34—46	3—5.1—10	2—3.9—8
C. mitchellii mitchellii	93	M	(23) 25—27	171—177—183	172—179—186	22—25—28	16—20—23	13—16—19	13—16—17	20—35—46	3—5.5—8	26—32—39	3—3.8—5	3—3.2—4
C. mitchellii pyrrhus	215	L	(21) 23—25—27	168—178—185	168—179—185	20—24—28	16—19—23	13—16—19	14—16—19	21—35—52	4—5.9—8	23—33—42	4—5.6—9	3—4.5—6
C. mitchellii stephensi	70	M	(21) 23—25	166—174—181	173—179—182	23—25—28	17—19—22	12—14—16	13—15—18	13—25—38	3—5.5—8	30—37—43	5—6.6—8	3—4.5—6
C. tigris	47	M	21—23—25 (27)	158—165—172	164—169—174	23—25—27	16—19—21	11—14—15	11—14—16	11—17—37	3—4.8—8	37—43—52	6—8.0—10	4—6.0—7
C. cerastes	316	M	(19) 21—23—25	132—142—151	135—145—153	17—21—26	14—17—20	10—12—15	10—13—16	12—19—34	2—4.3—6	36—36—47	3—4.7—7	2—3.8—7
C. polystictus	18	M	25—27	162—168—177	169—177—186	25—27—29	17—20—23	13—14—15	11—14—16	6— 8—10	1—2.9—5	35—42—47	5—6.1—7	4—5.1—7
C. horridus horridus	123	L	21—23—25	160—168—173	164—172—178	20—24—29	16—20—24	10—13—16	11—14—17	4—17—35	3—6.4—10	15—23—28	*	*
C. horridus atricaudatus	58	L	(21) 23—25	161—171—179	168—175—181	24—27—30	20—22—25	12—14—16	13—15—18	6—17—38	3—6.6—9	25—26—29	*	*
C. lepidus lepidus	22	S	21—23	148—160—166	154—161—167	22—25—27	19—19—21	11—12—13	10—11—12	6— 9—16	1—2.9—4	15—18—24	3—4.0—5	3—3.2—4
C. lepidus klauberi	133	S	(21) 23 (25)	152—161—171	155—163—172	21—25—28	17—20—24	10—12—14	9—11—13	5— 8—13	1—2.7—4	13—17—21	1—2.8—7	1—2.2—4
C. triseriatus triseriatus	69	S	21—23—25	138—150—161§	141—152—161§	25—28—32	17—21—26	9—12—14	9—11—13	1— 8—12	¶1—2.7—4	22—38—57	4—6.1—11	2—4.7—9
C. triseriatus pricei	107	S	21—23	150—157—167	152—162—171	19—25—29	18—21—23	8— 9—12	8—10—13	5— 7—11	1—2.3—3	37—51—60	4—7.4—10	2—6.2—9
C. stejnegeri	3	S	25—27	174—177—181	—	43—44—46	—	14—15—15	14—16—17	10—16—21	6—7.0—8	40—42—43	11—12—12	—
C. willardi	32	S	25—27 (29)	145—151—158	147—155—160	25—28—32	21—24—29	12—14—17	12—14—15	19—34—55	3—7.3—9	20—23—29	1—3.0—4	2—3.0—4
S. ravus	16	S	21—23	138—145—150	142—146—148	26—28—30	20—23—25	10—11—12	9—11—12	4	1	25—28—31	4—5.2—6	3—3.5—4
S. miliarius miliarius	76	S	21—23 (25)	122—131—136	130—135—140	28—33—37	25—29—32	9—11—12	10—11—13	4	1	25—32—41	6—9.5—13	5—8.0—12
S. miliarius barbouri	28	S	21—23	128—135—143	134—142—146	31—34—37	27—30—33	9—10—12	10—11—12	4	1	30—37—44	9—10.6—14	10—11.2—13
S. miliarius streckeri	99	S	(19) 21—23	123—128—135	123—130—135	30—34—38	26—31—34	9—10—12	9—11—13	4	1	22—30—40	8—10.2—13	7—9.3—12
S. catenatus catenatus	77	M	(21) 23—25—27	130—138—145	138—143—147	23—28—32	19—23—27	10—12—14	10—12—16	4	1	24—31—39	5—6.4—8	4—5.4—7
S. catenatus tergeminus	33	M	23—25	138—149—155	143—152—160	28—30—33	21—25—27	10—12—14	11—13—14	4	1	31—38—45	7—8.1—10	3—6.2—8
TOTAL	7948													

* The size category is roughly as follows: L (large) signifies a species of which the adult males often exceed 1000 mm (39 in.), M (medium) covers the range 650-1000 mm (25-39 in.), and S (small) that below 650 mm (25 in.). These figures refer to large rather than the extraordinary specimens which may be encountered occasionally, also the optimum habitat for the species is presupposed.

† The figure in italics is the mode, those in roman are of frequent occurrence, while those in parentheses are rare. In all other columns the first figure is the minimum, the central figure the average, and the last is the maximum. Freak specimens are not recorded.

‡ The tails are too dark to permit counting the rings accurately

§ Not including Panaco Island specimens which are higher

‖ Not including Oaxaca specimens which are lower

¶ Not including Guerrero specimens *imitemus* which are higher

Palmeri Garman, 1887. Syn. *lepidus.*
Piscivorus Lacépède, 1789. Not a rattlesnake *(A. piscivorus).*
Pulverulentus Cope, 1883. Syn *viridis.*
Pulvis Ditmars, 1905. Probably based on an albino *C.d. durissus,* but might be *C. unicolor.* More material is required for a decision.
Rhombifer Latreille, 1802. Syn. *adamanteus.*
Salvini Günther, 1895. Syn. *scutulatus.* May be a valid southern subspecies.
Simus Latreille, 1802. Syn. *durissus.*
Sonoraensis Kennicott, 1861. Syn. *cinereous.*
Strepitans Daudin, 1803. Description inadequate; probably syn. *durissus.*
Tesselatus Hermann, 1804. Cannot be recognized; resembles *triseriatus* in scale counts, and *durissus* or *adamanteus* in size and pattern.

SUMMARY OF CHARACTERS

To permit an additional check on the determinations which may be made by the use of this key, Table 1 is presented, giving some of the more important scale counts of the various species and subspecies. If it be found that the specimen under consideration differs extensively in some of these characters from the numerical range given in the table the result of the determination may be viewed with suspicion and a recheck should be made.

The setting forth of scale-count data in abbreviated form presents certain difficulties. The usual method of giving minimum, maximum, and average shows nothing as to dispersion, that is, how closely most of the specimens cluster about the mean; and if either the maximum or minimum represents a freak or defective individual (as is not infrequently the case) or an error in counting or sexing, the mental picture of the dispersion is distorted, overemphasis being placed on a single specimen out of the many which may have been examined. This is particularly true where broods of young have been included, since they often seem to contain freaks (especially if bred in captivity) which probably would not survive in nature. As an example of such a freak we have a defective juvenile female *lucasensis* with 170 ventrals; the lowest normal individual has 183. Again as a sample adult freak we note an *oreganus* with 33 scale rows, while no other specimen out of 1343 has more than 29 and only 6 have that many.

Even the average leaves much to be desired when we deal with a form which is territorially variable, since the resulting figure is dependent on the origin of the individuals comprising the group averaged. Thus male *cinereous* average 185.0 ventrals in California and 177.7 in southern Texas; obviously the relative numbers from each area which may be contained in the composite *cinereous* group will affect the average.

Only a graphic presentation, or a tabulation of the variation of each item in percentages, will give a true picture of the dispersion, but in a condensed table this is impossible. So also is the presentation of the in-

terquartile range and the probable error of the mean, which are of interest in a complete statistical statement.

For these reasons, while I have set forth in Table 1 the minimum, average, and maximum of each item, the minima and maxima are not always the extremes recorded; rather they are what might be termed the normal extremes, eliminating the solitary individuals here and there which seem to be freaks.

The numbers of scale counts available are also given as an indication of the validity of the figures. Obviously, where only a few specimens have been at hand, neither numerical ranges nor averages can be considered of much value.

USE OF KEY

The key is prepared in the usual dichotomous form, in which the selection is consecutively limited to one of successive pairs of alternatives. In the present instance, to facilitate reference, the alternatives are designated by the letters "a" and "b." Where one of the two leads directly to a species (and thus to a conclusion), the arrangement is such that the "b" alternative is selected to take this course.

No identification key can be made infallible when the forms are closely related or intergrade; and, in the case of the rattlesnakes, because of the great variability in their lepidosis and patterns, it has been particularly difficult to select key characters which lead invariably to the correct conclusion. This is not an argument against the validity of the species and subspecies which have been recognized; many characters which are important in taxonomic studies are unsuitable for use in keys because they presuppose the availability of other specimens for comparative purposes. Other characters require special preparation and are therefore seldom at hand, as, for instance, venom and extruded hemipenes. Even the scale counts, which are of primary importance in classification when handled statistically, are often of little use as key characters because of overlapping. Thus, while it can be shown that the difference between the number of ventral scales in *scutulatus* and *cinereous* is highly significant mathematically, there is a sufficient overlap so that the character becomes virtually useless in a key. Besides, a key must usually shunt out a single species from a group (those remaining undetermined at each point) and there is seldom a case in which some member of the group fails to overlap considerably, in these statistical characters, the single species it is desired to key out.

In accuracy of determination the present key leaves much to be desired. This is because of the frequency of aberrant specimens which deviate from the mode. For example, in *pyrrhus* we have occasional specimens which have prenasals in contact with the rostral; and some specimens of *ruber* have undivided first infralabials, while conversely, some *cinereous* specimens have these scales divided. The internasal criterion (see 23b) in selecting *viridis* and its subspecies, although the best character available, fails in an appreciable number of cases, as shown in the following table:

	SPECIMENS TESTED	FAILURES	PER CENT FAILURES
Viridis viridis	1837	37	2.0
Viridis nuntius	185	8	4.1
Viridis abyssus	30	1	3.2
Viridis lutosus	335	21	5.9
Viridis concolor	19	2	9.5
Viridis oreganus	1142	170	12.9
Total	3548	239	6.3

Oreganus, it will be noted, is conspicuously the worst offender.

Where possible, more than one key character has been set forth so that the selected path may be verified. As a result the key is no doubt subject to criticism on the score of prolixity; yet I know of no other way to secure even approximate accuracy with a group such as the rattlers, in which a single universally consistent key character is so seldom available for any species. Condensed keys often lead to unsatisfactory determinations in large genera, especially where a single specimen (rather than a large series from one area) is to be identified, as anyone will testify who has tried to use the existing keys for such genera as *Pituophis, Thamnophis, Sceloporus,* and *Uta.* In such keys long experience in the genus must be had before the key can be applied with accuracy.

In order to minimize further the effect of the key failures, a brief color description is incorporated with each alternative which leads finally to a species or subspecies; but the antithetical description is not given unless the pattern, or color, constitutes a part of the key. Occasionally footnotes direct attention to special deviations or to certain precautions which will reduce inaccurate findings.

Where color and pattern are a part of the key one should not only allow for the ordinary fluctuations within a species but must be on the lookout for melanistic or albinistic individuals (fig. 111). Partial albinos, with one or more color-principles lacking, are also met with; these are particularly confusing unless normal specimens from the same area are available for comparison. Preserved specimens, which are faded or from which the epidermis has been rubbed away through continued handling or drying, thus changing both color and pattern, must be guarded against in making comparisons. Preservation tends to dull the brighter colors into neutral grays and browns; this is especially true of red and yellow. Specimens which have been long in captivity sometimes rub their snouts on the barriers so continuously as to deform the rostral and internasals in shape and arrangement; such changes should be noted where the key uses these scales.

Under each species the range has been set forth, as far as known, and there should be no hesitancy in using this as a check on the determination, when the locality of collection of the specimen is available. Of

course if the specimen keys to a species known to occur only a short distance from the place of collection, the identification may be presumed to be accurate, for range extensions are to be expected in the future as larger and more thorough collections become available. On the other hand, if, for example, a Pacific Coast specimen is found to be *horridus* or *adamanteus,* the error must be in the key or its use, since neither of these species occurs within a thousand miles of that territory. The key is a working tool; imperfections are to be expected and therefore all information available on the specimen, including the locality, should be used to verify the determination.

RATTLESNAKE RANGES

The ranges are described as closely as the available specimens and records permit. To facilitate these descriptions tabulations and large-scale maps were prepared for each species or subspecies; altogether several thousand locality records were available, although comparatively few were at hand in the case of some of the rarer forms. In some areas—this is particularly true of Mexico—the authoritative records are rather scanty and the results have been somewhat generalized. Usually territories listed as within the range of a species are limited to those from which specimens or authentic records have been available; but in some instances where it is evident that a species occurs in intervening territory between two records, its presence there has been assumed.

Due allowance has been made for the character of certain early records. In the days of the Indian wars in the West, material was often gathered from a considerable area, yet was labeled by the recipient museum with the locality of the fort or army post from which it was sent. As a further complication these posts were sometimes moved for considerable distances without change of name. Therefore these old records have been neglected if they appear questionable, as indicated by currently available specimens and the present knowledge of habitat preferences.

Published locality records of species whose definitions have been confused in the literature have been discarded unless verified by specimens. Examples: *triseriatus* confused with *polystictus; cinereous* with *scutulatus; durissus* with *basiliscus* or *molossus,* and the latter with each other.

It should be understood that when an area is specified as the range of a species this does not mean that it is to be found universally distributed throughout that area. In some sections the encroachments of civilization, such as industrial and agricultural developments, irrigation, the cutting of forests, or drainage of marshes, have caused the disappearance of species from whole districts which they once inhabited. And even where natural conditions remain, a species is often not spread evenly throughout a territory. This is particularly true in the southwest, where ecological conditions vary greatly within short distances owing to changes in altitude or topography. Thus while three rattlesnakes may be said to occupy the same geographical area (a county, for example), one may

occur only on the plains, another amongst rocky foothills, and the third upon the higher peaks. None is found uniformly distributed over the entire area, yet the county would be included in the designated range of all three. Space limitations have made necessary the same type of generalization in the range maps which accompany this key.

SUMMARY OF RATTLESNAKE LIFE HISTORY

While it is impossible, within the scope of this key, to present a complete account of the life history of the rattlesnakes, it is desirable not to leave this feature untouched. The following paragraphs outline some of the more important or interesting facts concerning rattlesnakes and their ways. The necessity for abridgment has required rather broad generalization on some phases, and therefore this brief discussion should not be judged too severely by those already familiar with the subject.

Habitats.—While most species of rattlers thrive in arid or semi-arid areas, particularly in rocky or brushy country, there are others which are not averse to swamps or timbered lands. Some forms, such as *C. triseriatus,* seek mountain areas; *C.m. stephensi* prefers rock-strewn canyons; *C. cerastes* is at home in sandy desert wastes. In California, rattlers *(C.v. oreganus)* are found at an altitude of 11,000 ft., and in parts of Mexico *C.t. triseriatus* occurs up to 14,500 ft. They have been found on the sands of the seashore only a few feet from the waves and occasionally have been seen swimming in the sea as well as in lakes. While no rattlesnake is as aquatic as the water or garter snakes, they will take to water at times, and the little known *C. polystictus* may be semiaquatic. Rattlers being heavy bodied, are less arboreal than many other species of snakes; however they occasionally climb trees, no doubt in search of squirrels or birds. They are sometimes found crawling through chaparral well above the ground. Clumps of cacti are favorite refuges of some of the western forms, which are not impeded by the spines.

An adherence to a certain ecological niche cannot always be specified for a given rattlesnake. It is not only that some forms are more tolerant than others, which is the case, but that a species may be restricted in ecological range in one area and not in another, owing possibly to competition or other more obscure conditions. Thus *scutulatus* is a snake of the flatlands in the Mohave Desert; in Arizona it is not only a desert, but a foothill and even a mountain form. In Arizona *cinereous* is an Upper as well as Lower Sonoran form, but in southern California it is exclusively a desert inhabitant; here it has never secured a foothold even on the lower mountain slopes, probably owing to the competition of the closely related *ruber.* Hence in these brief notes it has often been impossible to cite the habitat preferences of a form because of this variability within a species.

It is probable that in pre-Columbian times at least one species of rattlesnake was found in every part of what is now the United States excepting eastern Maine, upper Michigan, northern Wisconsin, central and northern Minnesota, eastern North Dakota, and Washington and

northern Oregon west of the Cascade Mountains. The higher mountains were likewise untenanted, the altitude not invaded depending on local conditions. While in southern California rattlers have been observed at an altitude of 11,000 feet, further north and in the Rockies the more rigorous climate holds them to lower levels.

Where a species is approaching its toleration limit (in habitat conditions) its range may be highly irregular and intermittent. Thus only the lowlands in mountainous territory may be inhabited (as is the case, for example, in central Idaho and western Montana) and the range may be as irregular and broken as are the contours of the river-valleys, with further modification resulting from the nature of the exposure, for snakes range higher on slopes with a southern exposure.

As far as numbers of forms are concerned Arizona is the headquarters of the rattlesnakes, no less than 15 subspecies being found within the limits of that state. However, because of their restriction to certain ecological niches, as previously mentioned, it is doubtful whether more than 5 or 6 species actually meet in any one locality.

While rattlers have been exterminated in many industrial and agricultural areas, it is probable that in a few places they are now even more numerous than in primitive times. This may be the case where agricultural development, or the destruction of competitive predators, have served to increase the supply of rats, mice, gophers, ground squirrels, and the other rodents upon which most of the species feed.

Economic Status.—Rattlers are of considerable economic importance in many areas, since they serve as a check on destructive rodents. However, one would hardly recommend their protection, particularly adjacent to cities, because of the danger to humans inherent in their presence. It would be best if they could be replaced by other snakes such as the bull snakes, gopher snakes, and rat snakes, which have an equal economic value (in the destruction of harmful rodents) but, being harmless, do not have the one outstanding objectionable quality of the rattlesnakes, namely, their venomous character. Incidentally it may here be stated that when a person, through mental laziness, refuses to discriminate between harmless and venomous snakes, and kills all snakes at sight, he is defeating the very purpose of his act. Every time he kills a harmless gopher or king snake he is making room in the economic scheme of things for one more rattler, for the number of these snakes is limited by the available food supply.

Habits.—While rattlesnakes are diurnal in spring and autumn, they are largely nocturnal in summer, this being especially true of the species found in the Upper and Lower Sonoran Zones. In the spring when they first issue from hibernation, they are abroad in search of food and mates, and are rather careless of concealment. At this season they are occasionally found in pairs, but the widespread belief that if one rattler be killed its mate will shortly appear at the scene of the tragedy is quite erroneous. Later they become secretive, their activities being restricted largely to the

evening hours or night, when the heat is not excessive, and when the rodents which constitute their principal food are abroad. In the daytime they seek refuge in ground holes, in the shade of dense thickets, or under rocks. In the arid Southwest no rattlesnake can stand the direct heat of the summer sun. Under such conditions even the desert sidewinder will succumb within ten or fifteen minutes.

In the colder climates rattlers hibernate together in large numbers, going into hibernation about mid-October and emerging in mid-April, the dates varying somewhat with latitude and altitude. In some areas rocky retreats are preferred; in others, prairie dog towns or other ground holes. In milder climates the snakes do not gather in large groups for hibenation but seek separate refuges. Here they may come out briefly at any time during the winter if there is a warm spell.

Rattlers are secretive and timid. When approached they will usually remain quiet in order to avoid detection, and when discovered will endeavor to escape if given an opportunity. It is only when they are frightened and cornered that they will stand their ground with a strident warning to the intruder. Stories of rattlers chasing a person are probably the outgrowth of instances wherein the man stood between the rattler and his natural refuge, usually the nearest bush or rock cleft. Rattlers will not strike unless they are disturbed or frightened; they are not innately vicious, but seek only to defend themselves or escape. They do not always rattle before striking, as this depends on the disposition of the individual snake and the nature of the disturbance which has alarmed him. They can bite without coiling, but cannot strike without first throwing themselves into the loose S-shaped coil with raised forebody which constitutes the striking posture (fig. 108). The strike is merely a forward lunge of the head and rarely exceeds half the length of the snake; if the snake is violently excited, it might reach three quarters. At the end of the strike the mouth is widely opened and the forward pointing fangs (fig. 1c) are driven into the victim. The strike is made with such rapidity that the forward drive of the head cannot be followed with the eye; one can see only the white blur of the open mouth where the direction of motion is reversed. The head is retracted more slowly. The mouth is not opened until near the end of the strike; rattlers do not threaten their enemies with open mouth as sometimes pictured.

The resting coil (fig. 109) in which rattlers are usually found is quite different from the striking coil. A rattler cannot strike when in the resting coil, but if alarmed rears up and quickly throws himself into his characteristic defensive posture. The striking coil not only facilitates a possible forward lunge but also bodily maneuver, for in this posture the snake can move backward or to either side where a safe retreat may offer; but meanwhile he faces his foe, ready to strike if the enemy comes within range. A big rattler, thoroughly alarmed, is something both to see and hear. Not only is the rattle sounded continuously but the cornered snake inhales and exhales with a violent hiss; the posterior body is flattened;

and the protruding tongue is held alternately pendent, and vertically erect, with the tips widespread.

Rattlers, in the striking coil, rear up to about 6 to 12 inches with the head a trifle lower than the lateral curve of the neck; they strike slightly downward, usually well below 12 inches, so that heavy leather boots or puttees afford good protection for the legs. A large rattler can puncture thin flexible leather. *Crotalus durissus* has a striking posture resulting in a higher strike than that of our nearctic rattlers. Since rattlesnakes are not naturally vicious and do not attack unless disturbed, the principal danger to hiker or hunter results from walking along a trail without watching his step so that a rattler which has not been seen may be trod upon. Under such circumstances a rattler would bite without coiling or a warning rattle. Occasionally accidents happen to persons climbing about amongst rocks and placing their hands in a fissure in which a rattler lies concealed, or in walking abroad at night without a light. Farmers trimming shrubbery sometimes suffer from having disturbed a rattler lurking there. To city folk the best advice is, "Watch where you place your hands and feet; don't put them into places you can't see."

Rattlers, being thick of body, crawl rather slowly. Usually they adopt a sinuous motion (fig. 110); sometimes progression is caterpillar-like and they leave an almost straight trail. The sidewinder has a peculiar rolling motion, developed for efficient transit over loose sand. In this, with head anchored, the body is thrown to the side in a loop, after which the head is moved. The resulting track is not continuous, but is a series of short lines advancing *en échelon*.

Food.—Rodents, such as rabbits, ground squirrels, prairie dogs, gophers, rats, and mice, comprise the natural food of most species. Birds are occasionally eaten. Some of the smaller species, such as *lepidus, triseriatus,* and *cerastes,* are largely lizard feeders, although they do not scorn small rodents when obtainable. Rarely other snakes are eaten.

Rattlesnakes always strike and poison their prey; that is what the venom is for—to kill the prey; as a means of defense it is secondary and incidental. The prey is struck but not held by the rattler. The small animals quickly succumb to the venom and are then eaten, usually head first. The stomach juices of the rattler are very powerful and every part of the prey is digested except hair or feathers. It is probable that in their natural state they feed at approximately weekly intervals, if a full meal is obtained.

Rattlers do not feed well in captivity and many die of self-imposed starvation if disease does not supervene. They do not charm their prey but secure it by stealth, lying in wait for it to come within range of the deadly stroke. Most animals placed in a cage with rattlers show no fear of them. A hungry rat with no other food available will sometimes kill a rattler in whose cage it has been placed as food. Zoo visitors are heard to express surprise that two or more rattlers can be placed in the same

cage without an immediate fight. As a matter of fact being peaceful, they get along well with each other and with other snakes.

Size.—The largest of rattlesnakes is the Eastern Diamond, *C. adamanteus*, which reaches a length somewhat in excess of 2400 mm. (8 ft.) and a weight of more than 15 pounds. This is the largest, that is the heaviest, of all venomous snakes; the longest is the king cobra. Other very large species are *C. cinereous* and *C. durissus*. The smallest rattler is probably *C. willardi* or *C. stejnegeri*, which scarcely reach 590 mm. (2 ft.); the latter is also the rarest (in collections), only 3 specimens being available to date. For a rough classification of rattlesnakes as to length, see the appropriate column in Table 1.

Adult male rattlesnakes average larger than females by about 8 per cent; they are also somewhat more plentiful. Males can be distinguished from females by their relatively thicker and longer tails; in the females there is a distinct reduction of diameter where the tail begins, while in the males the taper at this point is more gradual. Rattlesnake growth is quite rapid during the first two years of life, after which it is much slower. The young of rattlesnake species having an average ultimate length of 1220 mm. (4 ft.) will be about 265 mm. (10½ in.) at birth. Rattlesnake lengths determined from skins are inaccurate owing to stretching.

Reproduction.—Our nearctic rattlesnakes mate in the spring, soon after leaving hibernation. The young are born between mid-August and early October, depending on the species and the geographical area inhabited. Although many kinds of snakes lay eggs, others, including rattlesnakes, are born alive. Broods vary in size from 2 or 3 to 30 or more, but average about 10. Female rattlesnakes give birth to their first broods when three years of age. Young mothers have smaller broods; also the smaller species have fewer young. Young rattlesnakes shift for themselves immediately after birth; occasionally a mother is found with her young, which probably have been born but a few hours before, or they are using a common retreat. The long-existent theory that parent rattlesnakes swallow their young for protection is not true.

Control.—Various methods of rattlesnake control have been tried, such as the use of snake-proof fences, blasting them out of dens, or poisoning them in such dens with liquids or gases. These means are not often effective; results are much more likely to be achieved by curtailing their food supply, that is, by eliminating the rodents upon which they feed. However, the great concentration of rattlesnakes at hiberating time does offer an opportunity to destroy large numbers within a short period. This is especially true in the colder climates. A. M. Jackley of South Dakota has devised means for capturing rattlers leaving hibernation, and has been successful in securing great numbers of *C.v. viridis*. Whether such destruction is to be recommended on economic grounds is an open question. Bounties have been proposed but cannot be recommended, since they often lead to the importation of snakes from other areas. Hair ropes, of course, are entirely ineffective in keeping rattlesnakes out of a camp; a snake

which does not hesitate to crawl over cactus could hardly be expected to notice a hair rope.

Forest and brush fires cause great destruction of rattlesnakes, as they do of all animals occurring in the devastated area. Autos kill many snakes upon the highways.

Rattlesnake Enemies.—Aside from man, the principal enemies of the rattlesnakes are birds and other snakes. Hawks and owls are sometimes observed carrying rattlers or other snakes in their talons. Ravens have been seen to attack young rattlers. A number of kinds of harmless snakes, including especially king snakes and racers, feed frequently or occasionally on other species of snakes, and rattlers are amongst those which fall prey to them. The attitude of the king snake toward rattlesnakes is often misunderstood. King snakes do not range about spoiling for a fight with a rattlesnake; however, when in search of food a young rattlesnake is as tempting a morsel as any other. Some mammals, including a South American skunk, are known to kill snakes. The mortality amongst young rattlesnakes is high, for they are especially vulnerable to birds and snakes. When they have reached maturity they are too much for some of their erstwhile enemies to handle.

Various of the hoofed animals, especially pigs, deer, and goats, are known to kill rattlesnakes, as well as other species. Snakes are said to be scarce where goats habitually graze.

Commercial Value.—Rattlesnake skins are used in the manufacture of such ornaments as belts, slippers, hat bands, purses, and the like. The flesh is edible and in Florida has been canned on a commercial basis. The venom when carefully segregated by species, purified by centrifuging and dried, is used in the treatment of horses in preparation of antivenomous serum; and has certain other medicinal uses upon which research is now being carried forward. Rattlesnake oil is sometimes in demand in certain oriental trade circles.

The snakes themselves are in sporadic demand for snake shows, carnivals, zoological gardens etc. Prices, when there is a market, range from $.50 to $10.00 each, depending on the size and species. The commoner kinds are often sold by weight, bringing from twenty to fifty cents per pound. With the exception of a few experienced and well organized firms which supply much of the American market for these products, few persons are successful in making a livelihood from any phase of the rattlesnake business, since the demand for snakes or snake products is at best sporadic and uncertain.

Finding snakes and catching them are matters of experience. Various kinds of noose-sticks are used for picking them up.* A practiced eye can discover snakes which the novice will overlook, as has often been demonstrated in the field by pointing to a patch of rocks amongst which

* For methods of catching and shipping rattlesnakes, see Klauber: Notes on Herpetological Field Collecting. S. D. Soc. Nat. Hist., Collecting Leaflet No. 1, pp. 1-10, 1935.

a snake lies in plain sight. A person who does not know what to look for will have great difficulty in locating the reptile.

The largest catches can be made about dens in the autumn or spring. In desert areas one catches snakes at night by driving on black paved roads, against which background the light-colored snake shows strongly under the glare of the headlights.

Rattlesnake farms, except for their possible exhibition value, are not often successful. In these farms the population is not replenished by breeding, but by acquiring fresh material continuously in the wild, it being impractical to breed snakes in captivity. Caged rattlesnakes are afflicted with diseases and a variety of internal and external parasites which shorten their lives. Rattlers seldom take food naturally in captivity, but often live for a year or more without it. However they must have water.

Rattlers in captivity quickly become lethargic; after a short time they are accustomed to human beings and do not greatly resent handling. Undue familiarity with rattlesnakes, however, is to be decidedly discouraged, as a sudden fright may result in a serious accident. A considerable proportion of snake-bite cases in this country results from handling captive snakes. Pulling the fangs out is an easy, but not a lasting, safety measure, since they will be shortly replaced; and if the operation is carried deeper and the reserve fangs or venom glands are removed, the snake usually dies within a short time.*

Senses.—Zoo vistors, unfamiliar with snakes, frequently are heard to confuse the snake's fangs (which cannot be seen unless the snake yawns) with its tongue. The tongue is a harmless and delicate organ, probably auxiliary to the sense of smell; or it may be partly auditory in function. It is frequently advanced and retracted, especially if the snake is in an unusual situation; with it the snake seems to be sensing his surroundings. An angered or defensive rattlesnake not only protrudes the tongue to the fullest extent but also alternately points it vertically upward and downward. These motions are not hurried, but are made with deliberation. The rattler's tongue is bifurcate and, in nearly all species, is black. When on the alert the tips are spread wide apart.

Rattlers, like other snakes, have ears, but they are without external aural openings. The hearing seems to be dull. The sight also is not of the best, judging by the frequency which captive rattlers are seen to miss their prey, even when it is within easy range. Possibly they see better at night. A short time prior to changing its skin a snake's eye coverings appear bluish and almost opaque. There is an exudation of a liquid between the old and new skins designed to facilitate shedding. At such times the snake is nearly blind. A day or so before exuviation the eye clears up.

The unique pit (fig. 6) which characterizes the snakes of the family *Crotalidae* (the pit vipers) is another sense organ, the purpose of which is uncertain, but is thought to be auditory.

* *Re* effect of captivity on rattlesnakes, see Klauber: A Herpetological Review of the Hopi Snake Dance. Bull. Zool. Soc. S. D., No. 9, p. 32, 1932.

Rattles.—The rattle is used for the purpose of warning away enemies which are large enough to cause possible injury to the snake. It is not employed (as has been sometimes stated) to warn prey; this would be contrary to reason. It is not a mating call as has been suggested; in excursions through snake-infested country during the mating season I have never heard a rattle sounded except by a snake that has been disturbed by my companions or myself.

In vibrating the rattle the tail is shaken at the rate of from 45 to 60 cycles per second, the speed depending both on the individual snake and the temperature. The sound, which is caused by the impingement against each other of the interlocking segments of the rattle string, cannot be distinguished as discrete impacts, for it is much too rapid; it is a hiss not unlike escaping steam. A large rattler can be clearly heard at a distance of a hundred feet or more; to have one of these suddenly let go immediately under one's feet is startling indeed. On the other hand, some species—*S. miliarius* for example—have such small rattles that they can scarcely be heard at a distance of a few feet.

The first rattle, or prebutton, is always lost with the first shedding of the skin, which occurs within a day to a week after birth, leaving the permanent button exposed; subsequently the snake acquires an additional rattle with each shedding. Snakes at an age of one year have from 3 to 6 rattles, the number depending on the species of snake and the duration of its seasonal activity. Thus the age of a rattler can only be approximated from the number of rattles, and then only if the button be present, showing that the string is complete. Rattles are lost through wear, so that strings exceeding 15 segments are extremely rare. I have not seen one with more than 13 segments which still retained the original button. Adult snakes usually have from about 5 to 10 rattles; the loss of the additional segments is not a detriment to the snake since long strings are inefficient vibrators. Rattlers living in places where they are seldom disturbed—for example on Tortuga Island—tend to have long strings. The same is true of species—such as the sidewinder—which inhabit sandy areas, for here the rattles do not often catch in the clefts of rocks or shrubs, nor are they abraded by rough objects. Long sets of rattles can be easily faked, which accounts for most of the phenomenal strings which have been reported.

The rattle consists of a horn-like material which is exuded and solidified on a corrugated matrix of tissue prior to the shedding of an old skin. The method whereby each new rattle is advanced one corrugation ahead of its predecessor and yet remains interlocked with it, is mechanically quite complex. It is effected by a wave action of tissue.

I wish to repeat that rattlers do not invariably sound their rattles before striking. Some are so peaceful—*C. ruber* for example—that they will neither rattle nor strike except under great provocation.

Fangs.—The fangs are two greatly elongated curved teeth at the front of the upper jaw. Normally they are folded back against the roof of the

mouth (fig. 1b), whence they may be rotated forward and downward into the striking or biting position (figs. 1d and 1e). Of this fang rotation the snake has voluntary control; the fangs are not automatically tilted as the snake opens his mouth. The movements of the two fangs on the opposite sides of the head are independent of each other. When in the resting position they are covered by a white protective sheath of tissue, which is partially pushed back from the points as the fangs are advanced. The fangs are hollow and have an upper and lower opening, the latter just above the point (fig. 1g). The venom is conducted from the venom gland, which lies back of the eye, through a duct to the upper opening (fig. 1l) and thence through the tubular fang to the orifice above the point, thus constituting a perfect natural hypodermic needle. Rattlesnake fangs are replaced at regular intervals even though they are unbroken. On each side of the head there is a pair of maxillary sockets which the active fangs occupy alternately (figs. 1g and 1h). While replacement is under way the old fang may remain in place while the new fang is being ankylosed in the adjacent socket; thus for a short time the rattler may have two fangs on a side. The reserve fangs, from which replacements are made, lie in an orderly series behind each functional fang. There are approximately eight on each side in successive stages of development from rudiments to almost complete fangs. As the reserve is drawn on for replacements additional buds appear, so there is no decrease in the number in reserve. In each individual fang, development takes place from the point upward. The fang develops as a tube, notwithstanding the central longitudinal suture (fig. 1g) which indicates that a remote ancestral form had fangs with open grooves, as is the case with some groups of venomous snakes today. The fangs of the several species of rattlesnakes differ somewhat in curvature and in length proportionate to the size of the head. The curvature aids in imbedding the fangs as the mouth closes.

Venom.—Rattlesnake venom is a yellow liquid having a specific gravity of about 1.08. It may be dried, without serious modification in toxic properties, by heating to 100° F; when dry it will retain its potency indefinitely. In drying, the venom loses about three-quarters of its weight. Dried venom has a yellow crystalline appearance, although the flakes are not true crystals.

The venom is primarily a means of securing food; venomous snakes practically always secure their prey by striking and poisoning it. In effect the venom not only kills the prey but is said to aid in its digestion. There are considerable differences, both in toxicity and physiological effects, in the venoms of the several rattlesnake species, some being 60 times as powerful, drop for drop, as others. Some are primarily hematoxic; others neurotoxic.

The yield of venom per snake varies greatly amongst the different species of rattlesnakes, even though the snakes may be of similar size. The following are a few adult averages, the figures representing the yield in milligrams of dried venom: *C. cinereous*, 270; *C. v. viridis*, 80; *C. v.*

oreganus, 140; *C. m. mitchellii,* 33; *C. m. pyrrhus,* 215; *C. cerastes,* 32; *C. tigris,* 11. A general, but not universal rule, is that rattlers which give low quantitative yields proportionate to their sizes have the most powerful venoms. So far as now known *C. tigris* has the most powerful and *C. ruber* the weakest venom. *C. durissus* seems to have a combination of high yield with powerful venom and therefore may be considered the most dangerous of the rattlesnakes. The maximum venom recovery from a single snake at a single milking was from a large *C. cinereous;* this produced 3.9 cc. of liquid or 1145 mg. of dried, purified venom. This is the highest record among over 4000 rattlesnakes that I have milked, and I know of no greater quantity reported from any kind of venomous snake.

A satisfactory procedure in "milking" large rattlers is as follows: An assistant catches the snake immediately behind the head by means of a noose-stick, and holds it with the head resting on the edge of the table. When the snake is so caught and held it has no opportunity to reach any object with its fangs and thus waste venom. The operator by means of a metal hook catches the snake's upper jaw under the rostral plate and tips the head back. Then the rim of a porcelain cup is introduced below the fang points, and the fangs are drawn downward and forward into the erected position. Since the head is tipped back and steadied by the hook while the cup approaches, the snake can neither see the cup nor slash at it until it is in position to catch any venom expelled.

As the fangs are drawn forward, the edge of the cup is pressed steadily against them; this tends to hold the head firmly and gives the snake a feeling of something yielding on which to bite. The hook is now withdrawn, and the operator, further forcing the head against the cup with his index finger, presses the venom glands with the thumb and third finger. The snake will usually eject some venom in an attempt to bite when it feels the steady pressure of the cup against the fangs, but in all cases the flow is increased by the mechanical manipulation of the glands.

Holding the snake with a noose-stick is not a suitable method for the smaller rattlesnakes, whether juveniles of the larger species or adults of the smaller, since their heads will not protrude far enough beyond the holding strap to permit manipulation. With these small specimens (say under 800 mm.) an operator can work most efficiently alone. In this process a centrifuge tube or test tube is firmly attached to a stand or vise. The snake is caught by pressing the head against the table with a short straight stick and is then grasped behind the head with the left hand. Using the metal hook to tip the head back, the fangs are hooked over the edge of the stationary tube and the glands are manipulated with the fingers of the right hand. The operator can keep the tail of the snake from thrashing about by placing it between himself and the work table, and then leaning against it.

Many operators recommend the use of a thin rubber or parchment cover for the venom cup or tube, to be bitten through by the snake. This may be justified for short-fanged snakes, but I have not found it efficient with rattlesnakes, since it impedes rapidity of operation, and does not

increase the yield. When a diaphragm is used, venom is frequently spilled on it before the fangs penetrate; and as the fang points cannot be seen after they have gone through the diaphragm, it is impossible to observe the effectiveness of the manipulation of the glands, or when the flow has ceased.*

In the wild, snakes are presumed to use only a small quantity of their venom in securing their prey, for no more is needed to cause the death of these small creatures within a minute or so. Rattlers have complete muscular control of the quantity of venom discharged, and naturally will not waste it. In biting an enemy in anger they probably eject from one half to two thirds of the quantity which may be secured by manipulation in the milking process.

It is presumed (but not definitely known) that a snake in the wild would replenish empty venom glands within two weeks or less. In captivity the secretion is much slower; snakes milked at successive intervals of two weeks show a sharply declining supply. For this reason a continual accession of fresh specimens is necessary for an adequate supply of venom.

Young snakes have venom at birth, but because of their small size it is quite limited in quantity; the bite of such an infant would probably be painful but not dangerous. Very old snakes show evidence of a declining venom secretion.

Snake Bite and Treatment.—Although rattlesnakes are moderately plentiful in many areas in the United States which are frequented by large populations, especially on week-end excursions, hunting or fishing trips, or by hikers or campers, rattlesnake bite constitutes a relatively small accident risk; not to be compared, for example, to the chance of a highway accident. The naturally inoffensive and secretive character of the snakes, and the fact that people going abroad are usually well protected about the legs, reduce accidents. Only in a few areas of our country is the snake bite problem sufficiently important to warrant much attention.

The gravity of a rattlesnake bite is something which cannot be closely defined or predicted, any more than one might predict the seriousness of a fall, without knowing the exact circumstances surrounding the accident, such as the height of the fall, the character of the surface struck, etc. And in a snake-bite case the conditions are even more obscure, since there are important factors which cannot be ascertained, even after the accident has occurred. So no one can give an off-hand opinion as to the gravity of such a case; and correspondingly, while there should be no desire to exaggerate the gravity, it will be best, in the interest of safety, to over-treat rather than under-treat the case, provided a proper treatment is used. In any event the victim should remain under close observation for at least 48 hours.

Some of the more important variable factors involved in snake-bite cases are the following:

* For the methods used in venom recovery and purification see Klauber: The Collection of Rattlesnake Venom. Bull. Antivenin Inst. of America, Vol. 2, No. 11, 1928.

(1) The size, vigor, and health of the victim, these being important in determining absorptive power and resistance to venom.

(2) The allergy complex of the victim; his susceptibility to protein poisoning; sensitization (anaphylaxis), or partial immunity imposed by previous bites and treatment. Some individuals are so susceptible to venom that the mere handling of it causes typical asthmatic symptoms lasting for 24 hours or more; most persons under similar circumstances are entirely unaffected.

(3) The psychological condition and nature of the victim; extreme fear and apprehension will affect heart action and therefore rapidity of absorption; and it is not impossible that there may be more direct reactions.

(4) The site of the bite, which will be less dangerous in the extremities, or in tissues where absorption will be less rapid (fat, for example), as compared to a bite near the vital organs or penetrating a vein.

(5) The nature of the bite, whether a direct stroke with both fangs fully imbedded, or a glancing blow or scratch. The movement of the victim (jumping backward, for instance) may cause a partially ineffective bite; or a bone may be struck, thus causing imperfect penetration. The snake may misjudge his distance and have the fangs only partially erected at contact, thus resulting in only slight penetration; or he may, for the same reason, eject venom before the fangs are imbedded.

(6) The protection afforded by clothing, which, by interposing thickness, will permit less depth of fang penetration, and will cause the external and harmless absorption of part of the venom. Only the point of the fang may penetrate the skin, in which case there will be no venom injection, for the orifice is well above the tip (fig. 1i).

(7) The number of bites; occasionally an accident involves two or more distinct bites.

(8) The length of time the snake holds on; it may withdraw or be torn loose before injection takes place. This is likely to be more important with the elapine snakes, with their less specialized fangs, than with such long- and hook-fanged snakes as the rattlers.

(9) The extent of the anger or fear upon the part of the snake. The muscles which wring the venom glands and thus inject venom are separately controlled from the biting mechanism. The snake's natural tendency is to withhold venom, since this is his means of securing prey; but if hurt or violently angered he is likely to inject a large part of the venom contained in the glands.

(10) The species and size of the snake, affecting venom toxicity and physiological effects, venom quantity, and (by reason of length and strength of fangs) depth of injection. The age of the snake is likewise important; not only are young snakes less dangerous because of their smaller size (and therefore reduced quantity of venom) but also the venom is less toxic, judging from the reduced proportional recovery of solids upon evaporation. Snakes which have passed their prime also probably secrete less venom and of a reduced quality.

(11) The condition of the venom glands, whether full, or partially depleted or evacuated by reason of recent feeding, defense, ill health, or captivity. The season of the year (proximity to aestivation or hibernation) may also cause a variation, but this is not definitely known.

(12) The condition of the fangs, whether entire or broken, lately renewed or ready for shedding.

(13) The presence, in the mouth of the snake, of various micro-organisms, some of which, gaining access to the wound, may, abetted by the anti-bactericidal effect of the venom, entail serious sequelae.

(14) The nature of the instinctive first aid treatment, if any, such as suction, or circulation stoppage by pressure.

To conclude, with variable factors of such importance, it is to be expected that some cases will prove extremely grave, whereas others may cause little or no discomfort. It is the latter class (which really require no treatment) that have given an entirely fictitious value and reputation to some of the remedies which have been proposed, for the patient recovers in spite of the remedy, rather than through its use.

In general, it can be said that even with the crudest treatment, or with no treatment of any kind, rattlesnake bite would probably not be fatal in more than 10 per cent of the cases, although greater with some especially dangerous species. Snake bite is likely to be more serious in the case of children, since the ability of a body to absorb venom without fatal results, varies with the weight. With proper treatment the mortality from rattlesnake bite should be less than 3 or 4 per cent.

In the case of an accident of this kind, be sure that the snake which has inflicted the wound is a venomous snake. Many harmless snakes will bite fiercely when trod upon or captured, but their bites are without any untoward effects; they are no more serious than a scratch and should be given a like antiseptic treatment. Nevertheless, there are authentic instances in which grave results and even death have been caused by fear following the bite of a harmless snake.

The actual injection of rattlesnake venom into a wound is followed immediately by severe local pain in almost every case, and this should be used as a criterion in determining whether the bite is that of a rattler, and if venom has actually been injected. With most species a marked swelling is also evident within a very short time.

Assuming that a person has actually been bitten by a rattlesnake, the following procedure should be adopted by the victim and his companions, if any be present:

(1) The victim should not become unduly alarmed or excited, and should not run, for to do so will speed up the circulation and the rapidity with which the venom is absorbed. Remember that few cases of rattlesnake bite are fatal.

(2) Apply a tourniquet between the bite and the heart. This may be a shoe string, necktie, or a rubber band. Rubber tubing makes the

best tourniquet. Do not tie it too tightly. Complete stoppage of the circulation is unnecessary and undesirable, but the venous flow should be impeded. Loosen the tourniquet briefly at 15 minute intervals.

(3) With a sharp instrument, such as a razor blade or a knife, make a cross-incision over each fang mark, or connect the two with a single incision. The depth should be about equal to that of the fang, say a quarter of an inch if the snake is of moderate size. Before using, sterilize the cutting instrument if possible, using iodine, alcohol, or the flame of a match.

(4) Apply suction to the wound and the incisions thus made, either with the mouth or using one of the cupping or suction devices* which have been placed in first-aid kits for this purpose. Apply this continuously for at least half an hour. In a healthy person with good teeth there need be no fear of getting venom into the mouth or stomach with untoward results.

(5) If antivenin is available, use it in accordance with the instructions accompanying the syringe. However, do not depend upon it as a cure-all. Remember that antivenin and suction are not mutually exclusive; use antivenin if available, but the suction procedure should be carried through in any case.

(6) If swelling or discoloration progresses up the limb, additional cross incisions should be made above this point and suction should be applied there, the tourniquet having been moved above the swelling. It is best to put on a second tourniquet before removing the first.

(7) If the patient is faint, give a cup of strong coffee or a teaspoonful of aromatic spirits of ammonia in a glass of water.

(8) Get the patient to a doctor or hospital as soon as possible, securing a physician experienced in previous snake-bite cases if one be available.

(9) Do not do any of the following things: Do not use potassium permanganate. Do not give whiskey. Do not burn or cauterize the wound, since this will interfere with the all-important suction and drainage. Don't use "folk-lore" remedies; they are a waste of time when time is valuable.

(10) If the physician in charge of the case has not had previous experience he can secure advice from the United States Public Health Service by wire. The case should be closely watched for the first 24 and preferably the first 48 hours. Some cases have been lost because the decline in the prominent hemorrhagic symptoms (evidenced by local swelling and discoloration) seemed to indicate that the danger was past, to be followed by a sudden and unexpected onset of neurotoxic symptoms. It

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* The rubber-bulb type is probably to be preferred since it will continue its action without an operator.

is suggested that physicians called upon to treat rattlesnake bite, study the publications of the United States Public Health Service, or those of Dr. Dudley Jackson of San Antonio, who has had a wide experience in this field; also the literature accompanying some of the suction devices now on the market in safety-first kits,* and the publications accompanying antivenin ampuls contain much useful information. It should be remembered, however, that these directions may be slightly biased as there has been some factional disagreement concerning the relative merits of antivenin and suction. I repeat that antivenin and suction are not mutually exclusive remedies; both should be used extensively in serious cases. The victim should always be typed so that a blood transfusion, if necessary, may be made without delay. Neurotoxic symptoms, frequently involving paralysis of the respiratory center, call for additional antivenin treatment The physician will use intravenous injections of glucose and normal salt solution as necessitated.

The carrying of kits containing suction devices (there are several good ones on the market) is to be recommended to campers, hunters, or others going into rattler infested country. This is said without any desire to frighten people or to exaggerate the chance of snake bite, which is indeed remote. It is, however, a reasonable insurance precaution.

The above brief remarks on the treatment of rattlesnake bite do no more than skim the surface. It must be remembered that most of the experience in this country has been in the treatment of cases of *C. cinereous* bite and that of closely allied species. Rattlesnake venom is an exceedingly complex protein poison, having a variety of effects, neurotoxic, hemolytic, cytolytic, anti-bactericidal, etc. These effects probably differ considerably in the several species. It is well known that the venom of *C. durissus* differs extensively in its effects from that of *C. cinereous* and some of our more common nearctic species. We may well expect that future research will show that others of our North American rattlers have quite different effects than has *C. cinereous*. This in turn may influence the development of antivenins and otherwise profoundly change the present recognized methods of treatment. Polyvalent antivenins cannot be made as effective as those to counteract the bite of specific snakes. Probably this is one of the reasons why Brazilian anticrotalus serum has been so successful; as there is but one species of rattlesnake in that country the antivenin is specific. In our country the situation is quite different. I anticipate that the future will see the venoms of our rattlers grouped in classes, with an antivenin for each class, although this could not be a successful commercial venture. In extensive areas of the country, where only one or two species of rattlers occur, only a single class would be required.

* The directions accompanying the Dudley First Aid Kit are particularly complete with respect to the procedure of the suction treatment, both in the field and hospital.

THE BITING MECHANISM OF THE RATTLESNAKE

Explanations of figs. 1 to 1n inclusive.

Fig. 1. Dorsal View of Skull of *Crotalus (C. ruber).*
The bones of the rattlesnake skull are thin and delicate. One of the distinguishing characters of snakes is the lack of a bony connection between the anterior ends of the mandibles, there being only an elastic ligament between these outer ends. This arrangement greatly facilitates the distension of the jaws, and by the independent action of the two sides, permits swallowing objects which are large relative to the size of the head.

Fig. 1a. Ventral View of Skull.
Note that the fangs are shown in the two outer maxillary sockets. This location is one of pure chance; with equal justification both might have been shown in the inner sockets, (see figs. 1g and 1h), or one in an inner and the other in an outer socket. As explained below, the fangs occupy the sockets alternately, and there is no synchronism in occupancy between the two sides of the head.

Fig. 1b. Lateral View of Skull.
The fang is folded against the roof of the mouth in its resting position. The lower jaw is dropped slightly, and the reserve fangs are omitted for clarity. This is not a cross section of the skull; it is a view of the outside from the left.

Fig. 1c. Lateral View of Skull.
The mouth is wide open and with the fangs directed forward in the position assumed at the end of the strike.

LEGEND: THE BONES OF THE RATTLESNAKE SKULL
(Figs. 1 to 1e, inclusive)

1. Prexamilla (premaxillary)
2. Prefrontal (lachrymal of some authors)
3. Frontal
4. Parietal
5. Basisphenoid
6. Squamosal (supratemporal of some authors)
7. Maxilla (maxillary or supermaxillary)
8. Palatine (palatal)
9. Pterygoid (internal pterygoid)
10. Ectopterygoid (external pterygoid or transpalatine)
11. Quadrate
12. Mandible (mandibular)
    12a Dentary
    12b Articular
13. Pro-otic
14. Exoccipital (lateral occipital)
15. Poison fang
16. Mandibular teeth
17. Pterygoid teeth
18. Palatine teeth
19. Supraoccipital
20. Stapes (or columella auris)
21. Postfrontal
22. Basioccipital
23. Nasal
24. Turbinal
25. Vomer

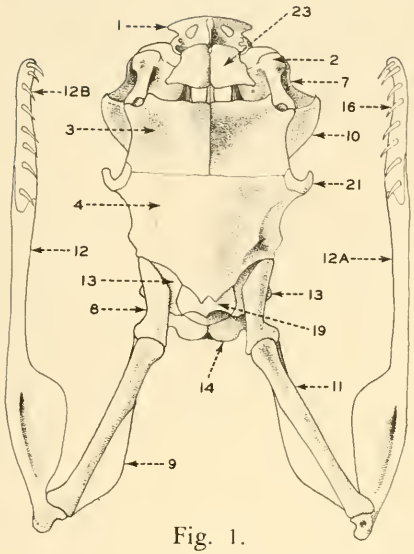

Fig. 1.

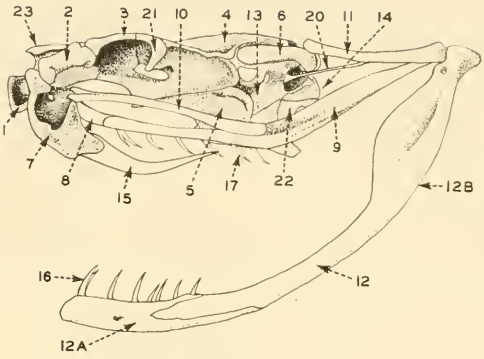

Fig. 1b.

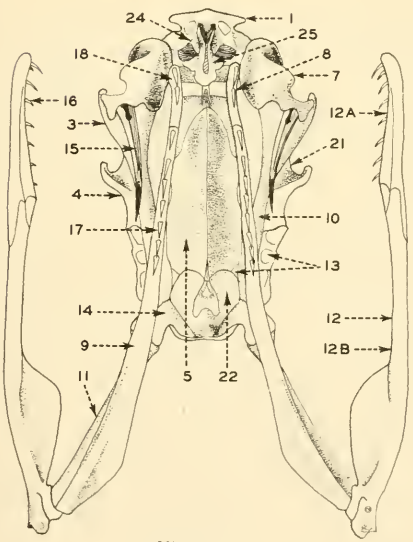

Fig. 1a.

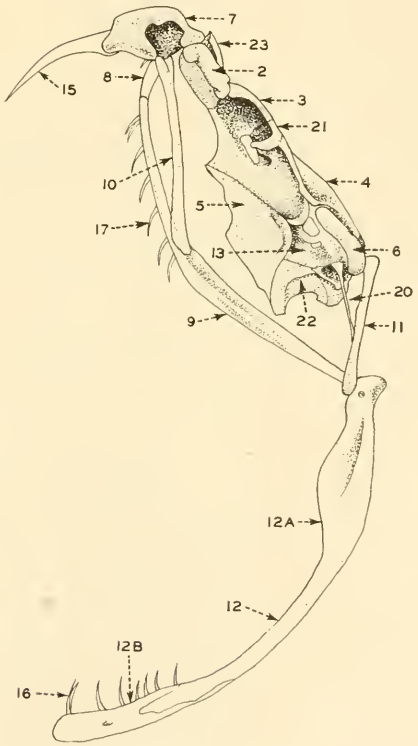

Fig. 1c.

Figs. 1d and 1e. The Fang Tilting Mechanism.

The bones of the skull are indicated as a linkage. Fig. 1d shows the fang at rest against the roof of the mouth; in fig. 1e the change in the angle between the frontal-parietal-supratemporal and the quadrate tilts the fang forward into the biting position by pushing forward on the maxillary. The fang is not rotated forward automatically by the opening of the mouth; the tilting is controllable, otherwise the fangs would interfere with swallowing food. Each fang may be tilted independently, as the bones on one side of the head are independent of those on the other.

Fig. 1f. Lateral View of Fang Seated in Maxillary.

Figs. 1g and 1h. Front View of Fang.

Fig. 1g shows a fang in the inner maxillary socket; in fig. 1h the next succeeding fang has been seated in the outer maxillary socket, while the fang shown in fig. 1g has dropped out. In this way succeeding active fangs occupy the two sockets alternately. (It should be noted that, because of the curvature of the fang, the lower part, in these figures, is viewed at an angle. This makes the orifice appear closer to the point than is really the case. See fig. 1i).

Fig. 1i. Point of Fang (Perpendicular view).

Figs. 1j and 1k. Cross Sections of Fang.

Fig. 1j shows a cross section of the fang at the upper end just below the lower edge of the maxillary in which it is anchored. Fig. 1k is a cross section just above the lower orifice.

Fig. 1l. Phantom Lateral View of Rattlesnake Head.

This illustrates the location of the venom gland and duct in relation to the fang.

Fig. 1m. The Position of the Reserve Fangs.

The reserve fangs do not tilt with the active fang but remain in place against the roof of the mouth.

Fig. 1n. Diagram Showing Fang Succession.

The two large circles represent the maxillary sockets, the left-hand being occupied by a functional fang. When this is ready to drop out, reserve fang No. 1 advances and becomes anchored in the vacant socket on the right. Later, when No. 1 is about to be superseded, No. 2 advances into the left-hand socket. Thus, the replacements are made periodically. New buds also appear periodically, so that, in all, about 8 reserves, in consecutive stages of development, are always present. The reserves which will ultimately be seated in the left-hand socket are separated from those intended for the right by a membranous wall. It should be understood that this discussion has had reference exclusively to the condition on one side of the upper jaw. There is a duplicate set of sockets and reserve fangs on the other side. In this diagram the reserve fangs have been spread out for reasons of clarity. Actually they lie closely bunched in a membranous sac above the active or functional fang, in the position indicated in fig. 1m.

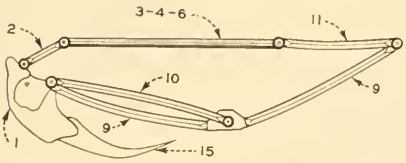

Fig. 1d.

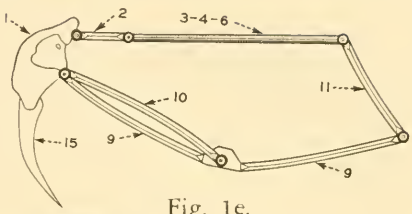

Fig. 1e.

Fig. 1f.

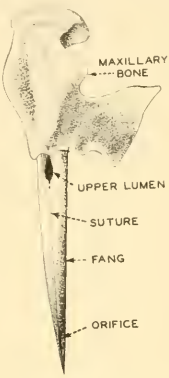

Fig. 1g.

Fig. 1h.

Fig. 1i.

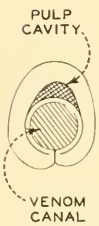

Fig. 1j.

Fig. 1k.

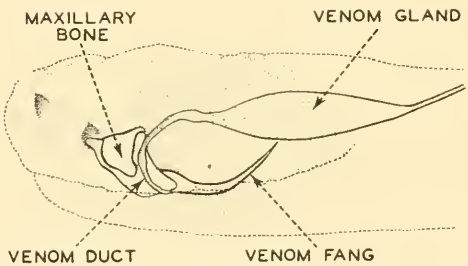

Fig. 1l.

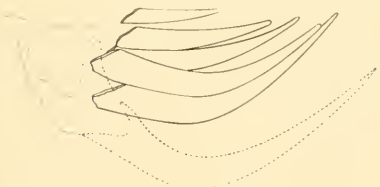

Fig. 1m.

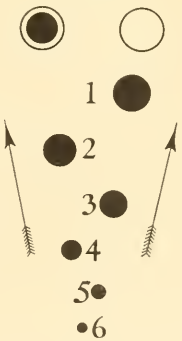

Fig. 1n.

GLOSSARY

While many users of this key will be familiar with the technical terms employed, such as the names of the scales used in herpetological classification, there may be others, especially physicians interested in snake-bite cases, who may not have had occasion to employ them. In addition there are certain peculiarities of the rattlesnakes which render it desirable to explain a few of the terms to those who have not worked in this group. For these reasons an illustrated glossary has been included.

Anal plate: The large plate covering the vent (fig. 3). It marks the division between body and tail.

Apical scale-pits: A pair of depressions faintly evident on the posterior end of each scale; usually most evident dorsally near the tail.

Body blotches: These are counted from the posterior edge of the head to the anus; the tail rings are not included. On the sides there are usually additional series of smaller blotches known as the lateral or secondary blotches, often in several rows, one below the other. In many species of rattlesnakes, especially on the posterior half or third of the body, the main dorsal blotches merge with the laterals to form crossbars or rings.

Button: See rattles.

Canthals: The border scales of the crown between the internasals and the supraoculars (fig. 5). For intercanthals see prefrontals.

Canthus rostralis: The outer edge of the flat area of the crown where it turns downward on the side, extending from the rostral to the supraocular (fig. 5).

Caudals: See subcaudals.

Frontal: The large plate between the supraoculars in *Sistrurus* (fig. 4). In *Crotalus,* this space is filled with scales more or less irregularly disposed (fig. 5) and is referred to as the frontal area, and the scales as the intersupraoculars. When the "minimum scales between the supraoculars" are specified, the path traversing the fewest scales is meant; this is usually at the anterior part of the frontal area.

Genials: The genials or chin-shields are a pair of enlarged scales back of the first infralabials (figs. 7 and 8). Occasionally the posterior tips of the first infralabials are cut off to form an extra pair of triangular scales which are called intergenials (fig. 46). Snakes other than rattlesnakes often have two pairs of genials, an anterior and posterior.

Gulars: The small scales covering the underside of the head between the two rows of infralabials and not otherwise specifically named (fig. 8).

Head marks: Although there is a considerable variation in the head marks of the rattlesnakes there are some which occur in many species; these are indicated as to general position and direction in figs. 9 and 10. The light supraocular crossbars in some species are present only on the supraoculars and not in the intervening frontal area.

Infralabials: See labials.

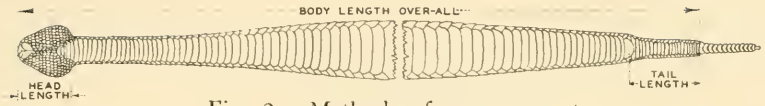

Fig. 2. Methods of measurement.

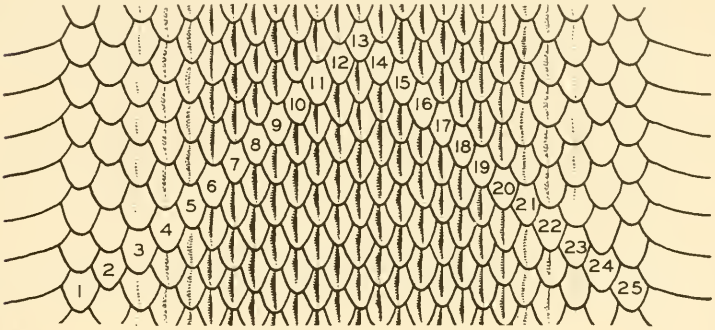

Fig. 2a. Method of counting dorsal scale rows.

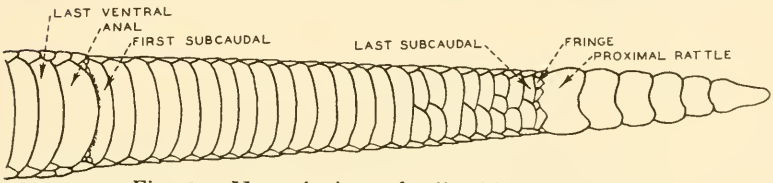

Fig. 3. Ventral view of tail with nomenclature.

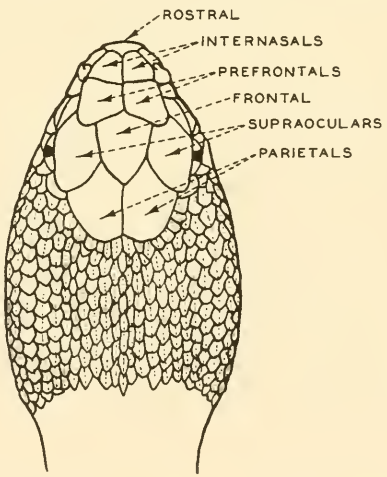

Fig. 4. Nomenclature of head scales of *Sistrurus*.

Intercanthals: See prefrontals.

Internasals: The scales in contact with the rostral from nasal to nasal regardless of size (figs. 4 and 5). In most rattlesnakes there are two; in *viridis* generally three or more (fig. 49).

Intersupraoculars: See frontal.

Labials: Bordering the mouth above are the supralabials (or upper labials) which extend from the rostral to the rictus of the mouth or commissure (figs. 6 and 7). The rostral is not counted as one of the supralabials. Similarly the infralabials (lower labials) extend along the lower lip from the mental to the angle of the mouth (figs. 6, 7, and 8). The first pair of infralabials are sometimes divided transversely (fig. 42).

Lengths: The length over-all (or body length) is measured from the tip of the snout (rostral) to the forward edge of the proximal rattle (fig. 2). Head length is measured from the rostral to a line joining the posterior tips of the mandibular bones. Tail length is from the anus to the forward edge of the proximal rattle.

Loreals: The scales (one or more) on the side of the head between the postnasal and the preocular (fig. 6). No species of rattlesnake is regularly without at least one loreal on each side, although rarely an individual will have none.

Mental: The triangular scale at the anterior tip of the lower jaw (figs. 7 and 8). Occasionally the posterior tip of the mental may be cut off to form a submental (fig. 47).

Nasals: A pair of scales on either side of the nostril, called respectively, the prenasal and postnasal (figs. 6 and 7).

Oculars: The scales surrounding the eye. The supraoculars are large and jut over the eyes (fig. 6). In front of the eyes there are usually two preoculars, the upper larger, the lower narrow and crescent shaped. Back of, and below the eye, are the postoculars and suboculars. It is usually difficult to determine which scale should be considered the lowest postocular, and which the first subocular.

Parietals: A pair of large plates posterior to the supraoculars and frontal in *Sistrurus* (fig. 4). This area is occupied by irregular scales in *Crotalus* (fig. 5).

Pit: A deep depression on the side of the head below and back of the nostril (fig. 6); this is the external opening of a sensory organ, probably auditory in function. Where the pit-border scales are mentioned, those constituting the internal rim or lip are meant, rather than those which are completely external to the pit.

Postnasals: See nasals.

Postoculars: See oculars.

Prefrontals: In *Sistrurus* the two large plates posterior to the internasals (fig. 4). In *Crotalus*, with a few exceptions of which *durissus* is an example, this space (often referred to as the prefrontal area) is filled with irregularly disposed scales called the intercanthals (fig. 5).

Prenasals: See nasals.

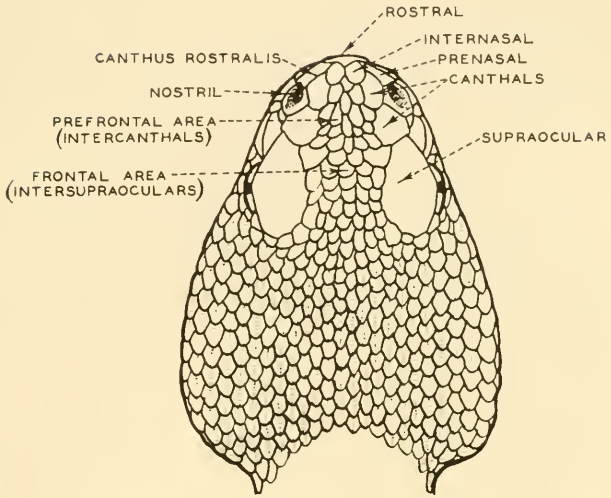

Fig. 5. Nomenclature of head scales of *Crotalus,* dorsal view.

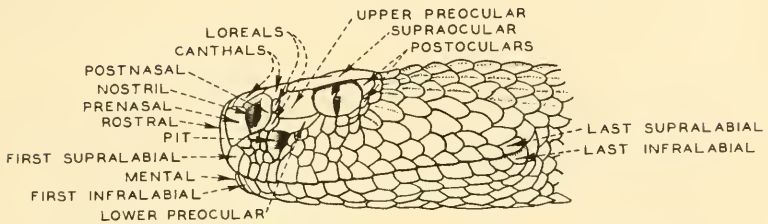

Fig. 6. Nomenclature of head scales of *Crotalus,* lateral view.

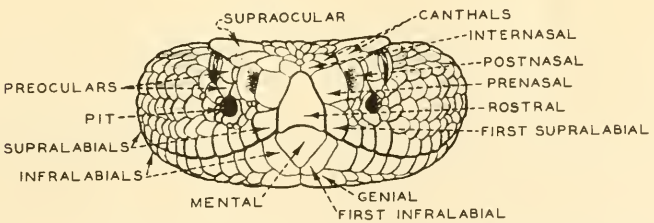

Fig. 7. Nomenclature of head scales of *Crotalus,* front view.

Preoculars: See oculars.

Rattles: The rattle terminology is illustrated in figs. 11 and 12. The proximal rattle is that next the tail and is the one most recently added to the string. The button (or rattle-button) is the first permanent rattle acquired by a young snake, the rattle present at birth (the prebutton) being invariably lost with the first exuviation. The button remains as the posterior terminus of the rattle-string until lost by breakage; it is usually present in juveniles or young adults, but rarely in older specimens. In some snakes, particularly if only one or two rattles have been lost, it is a trifle difficult to tell whether the button is still present; however this can be ascertained quite definitely with a little practice in the study of juvenile termini. The rattle width of any segment is measured as indicated in fig. 12. It is to be noted that the measurement (to secure the greatest width) is not exactly vertical, this being the result of the asymmetry in the rattle shape designed to prevent the rattle from dragging on the ground as the snake crawls. In this key the widths of the proximal rattle and the button are occasionally used.

Rostral: The large scale on the front of the nose (figs. 4, 5, 6 and 7).

Scale-boss: A knobby prominence or swelling on the posterior part of each scale, particularly evident on the middorsal rows of some species. It is to a certain extent independent of the keeling (or central ridge on each scale) which is present on all but the one or two lowest dorsolateral rows in all rattlesnake species.

Scale rows: Where the number of dorsal scale rows is given, the number at midbody is meant, beginning with the row next to the ventrals on one side and ending with the corresponding row on the other (fig. 2a). Occasionally the scale rows at the center of the tail are referred to; these should be counted midway between the anal plate and the anterior edge of the proximal rattle.

Subcaudals: The subcaudals (caudals or urosteges) are counted beginning with the first scale on the mid-ventral line posterior to the anal plate and ending with the last scale anterior to the proximal rattle (fig. 3). Divided scales, that is, those having mid-ventral sutures, frequently found toward the beginning or end of the series, are treated as if undivided. The fringe of small and irregular scales which occasionally covers the anterior edge of the rattle is not counted as a caudal.

Supralabials: See labials.

Supraoculars: The large plates above each eye (figs. 4, 5, 6 and 7). Also see oculars.

Suture: A division or crease between two scales or plates, or the parts of a plate.

Tail rings: The dorsal rings between the anus and the proximal rattle. They are often obscure and can only be counted approximately.

Ventrals: The large plates on the belly. In counting the ventral plates (sometimes called the gastrosteges) the count is begun with the first scale on the underside of the head which is distinctly wider than long (fig. 8), and ends with the scale anterior to the anal plate, but does not include the the latter (fig. 3).

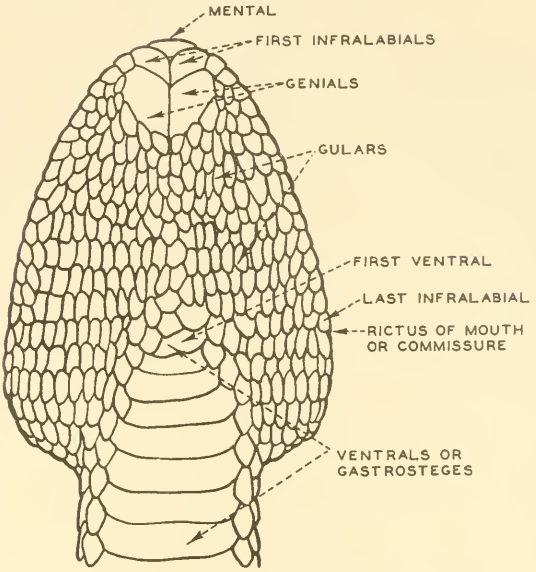

Fig. 8. Nomenclature of head scales of *Crotalus,* ventral view.

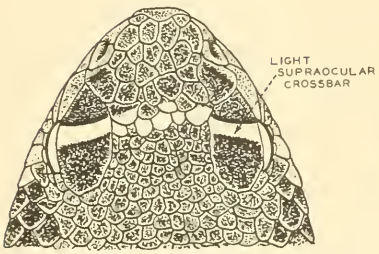

Fig. 9. Head pattern of *Crotalus.* dorsal view.

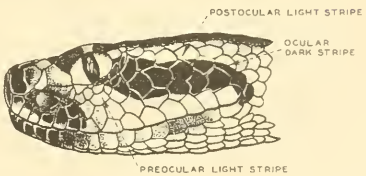

Fig. 10. Head pattern of *Crotalus,* lateral view.

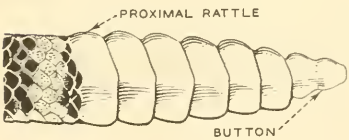

Fig. 11. Complete rattle with button.

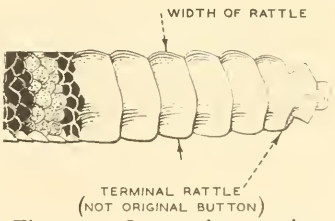

Fig. 12. Incomplete rattle.

METHOD OF EMPLOYING THE KEY

Start at 1 and decide whether the specimen to be identified is correctly described by paragraph 1a or by 1b. If the former be the case, the snake belongs to the genus *Sistrurus;* if the latter, to the genus *Crotalus*. Assume, in this instance, that it is a *Crotalus*. Note that the bold-faced figure 7 appears at the end of the final line in paragraph 1b; this is an instruction to proceed to the paragraphs headed 7a and 7b. Now decide which of these alternative descriptions fits the specimen in hand. If it fits description 7a, note that the bold-faced figure 8 appears at the end of the last line of the description; you are therefore next to choose between paragraphs 8a and 8b. If, on the contrary, course 7b is found to be the proper one, then the specimen is *Crotalus stejnegeri* and the identification is concluded. Thus by successive selections of one of pairs of alternatives a final decision is reached.

When an identification has been made it is recommended that the color description, the range, and the photograph (if one is given) be also checked against the specimen and its data, so that an inaccurate conclusion may be avoided, even if some peculiarity of the specimen, or ambiguity in the key, has caused a wrong turning at one of the branch points. The table of scale counts may also serve as a check.

It should be observed, with reference to the line drawings in the text (figs. 1–64), that the stippling is usually not for the purpose of indicating punctations in the pattern of the snake but more often serves to suggest the even application of some color other than black.

* * * * * * * *

The writer will welcome correspondence with users of this key calling his attention to errors or discrepancies. New locality records, especially if verified by live or preserved specimens (heads or skins are usually sufficient for identification), will be much appreciated in order that the range maps may be more accurate in future publications.

ACKNOWLEDGMENTS

To the many persons and institutions which have assisted me by the gift and loan of specimens during this investigation of the rattlesnakes I shall make acknowledgments in subsequent papers. At this time however I wish to give credit for the line drawings in this key to Mr. Norman Bilderback, and for the photographs, maps, and also the lettering on the drawings to Mr. Leslie C. Kobler, both of San Diego.

KEY

1 a. Top of head with large plates anteriorly (usually 9 in number) including a single frontal and a pair of large, symmetrical parietals in contact (fig. 13).* Genus **Sistrurus** 2

1 b. Top of head with scales of varying size; more than one scale in the frontal area; parietals, if enlarged, not in contact, nor symmetrical (fig. 14). Genus **Crotalus** 7

2 a. Rostral not curved over the snout (fig. 15); canthus rostralis sharply angled; dorsal series of body blotches about equal in width and length, or shorter (along the snake) than wide. 3

2 b. Rostral curved over the snout (fig. 16); canthus rostralis rounded, not sharply angled; dorsal series of body blotches distinctly longer than wide (fig. 17). A pattern of dark-brown blotches on a light-brown ground-color, with a lateral series on each side shorter (longitudinally) and usually darker than the dorsal series.

Sistrurus ravus

A small area of the Mexican plateau including: eastern México (state), southern Hidalgo, Tlaxcala, northeastern Puebla, west-central Veracruz, and northern Oaxaca (fig. 73).

3 a. Upper preocular usually in contact with postnasal; usually 3 supralabials in contact with the pit-border scales (fig. 15); 11 or more dorsal scale rows at center of tail; rattles larger, width of proximal rattle being contained in body length (over-all) less than 90

* Deviations of snakes of the genus *Sistrurus* from the standardized arrangement of the nine large plates on the crown (as illustrated in fig. 13) are not particularly rare, but such deviations usually consist of small and insignificant extra scales detached from the posterior end of the frontal or, less often, from the rostral. It is quite rare to find the nine large plates themselves seriously distorted in arrangement, although specimens have been noted with a central prefrontal and a canthal on either side. None of these aberrant specimens will be confused with any *Crotalus* individual if the criteria given in the key be followed, for although there are *Crotalus* species (*durissus* for example) which have large paired internasals and prefrontals (fig. 56), they lack the single frontal, and the paired and conterminous parietals of *Sistrurus*.

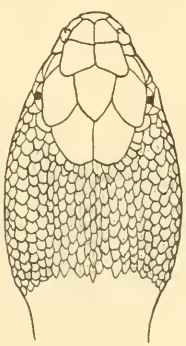

Fig. 13. Dorsal head plates of *Sistrurus (S. c. catenatus).*

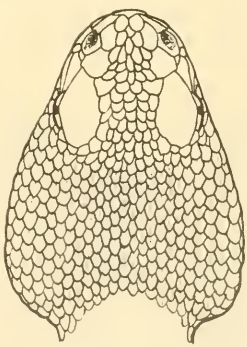

Fig. 14. Dorsal head scales of *Crotalus (C. cinereous).*

times, or in head length less than 6 times; no red or orange in the interblotch spaces on the middorsal line. **Sistrurus catenatus**

(For subspecies continue on to 4)

3 b. Upper preocular not in contact with postnasal; usually 2 supralabials in contact with pit-border scales (fig. 18); 10 or less dorsal scale rows at center of tail; rattles smaller, width of proximal rattle being contained in body length more than 90 times, and in head length more than 6 times; usually with red or orange between the blotches on the middorsal line. **Sistrurus miliarius**

(For subspecies continue on to 5)

4 a. Undersurface dark, heavily clouded with black blotches, often almost solid black (fig. 19); scale rows usually 25; body blotches usually less than 37. A pattern of square, red-brown, or black blotches on a gray-brown ground; sometimes unicolor black. **Sistrurus catenatus catenatus**

(Fig. 106).

From central New York westward to eastern Oklahoma including: New York from Madison County west; southern Ontario, south and west of the line Spanish—North Bay—Port Hope; extreme western Pennsylvania; northern and central Ohio; lower Michigan (including Bois Blanc Island); central and northern Indiana; Illinois; southern and western Wisconsin; eastern and southern Iowa; extreme southeastern Nebraska; Missouri; eastern Kansas and eastern Oklahoma, intergrading here with *S.c. tergeminus* (fig. 73).

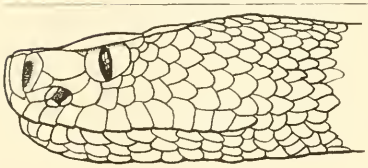

Fig. 15. *S. c. catenatus,* showing rostral not curved over snout; also preocular contacting postnasal.

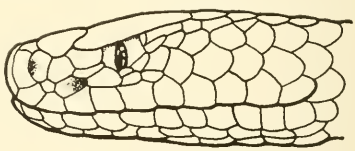

Fig. 16. *S. ravus,* showing rostral curved over snout.

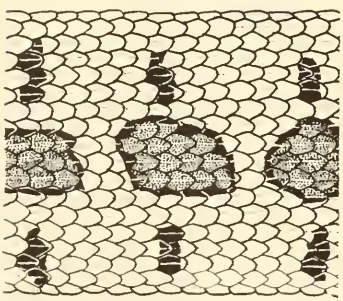

Fig. 17. *S. ravus;* body pattern.

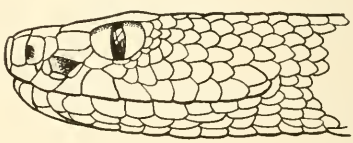

Fig. 18. *S. miliarius,* showing preocular separated from postnasal.

4 b. Undersurface mottled or spotted, the dark areas being less extensive than the light (fig. 20); scale rows often 23; body blotches usually more than 36. A pattern of dark red-brown blotches on a gray-brown ground. **Sistrurus catenatus tergeminus** *(Fig. 107).*

The southwestern plains including: central and southwestern Kansas; extreme southeastern Colorado; central and western Oklahoma; the plains areas of central and southern New Mexico; extreme southeastern Arizona; Texas, west of the Brazos River; and extreme northern Tamaulipas, Mexico. Intergrades with *S.c. catenatus* in eastern Kansas and Oklahoma (fig. 73).

5 a. Dorsal coloration brown or light-gray; ventral surface cream, moderately flecked with brown or gray; head markings distinct; lateral spots in 1 or 2 series. 6

5 b. Dorsal coloration dark-gray to black; ventral surface white, heavily blotched with dark-brown or black; head markings obscure; lateral spots in 3 series. **Sistrurus miliarius barbouri** *(Fig. 104).*

From extreme southern South Carolina (where it intergrades with *S.m. miliarius*) and southern Georgia, south throughout Florida and westward across southern Alabama to southeastern Mississippi, intergrading with *S.m. streckeri* in the Pearl River Valley (fig. 73).

6 a. Dorsal scale rows usually 21; dorsal spots wider than long and with irregular edges; lateral spots usually higher than wide; ventral spots confined to individual plates. **Sistrurus miliarius streckeri** *(Fig. 105).*

From the Pearl River Valley of southeastern Louisiana and western Mississippi (where it intergrades with *S.m. barbouri*) westward through Louisiana and eastern Texas (north of Lat. 28°) to Long. 98°; also north through Arkansas to southern Missouri and west to central Oklahoma; also southwestern Tennessee (fig. 73).

6 b. Dorsal scale rows usually 23; dorsal spots oval or subcircular, edges even; lateral spots usually round; ventral spots usually occupying two adjacent plates. **Sistrurus miliarius miliarius** *(Fig. 103).*

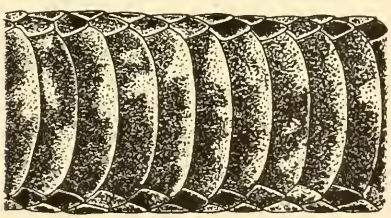

Fig. 19. *S. c. catenatus;* ventral pattern.

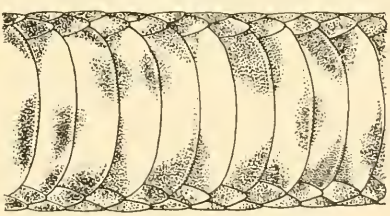

Fig. 20. *S. c. tergeminus;* ventral pattern.

From extreme southern South Carolina (where it intergrades with *S.m. barbouri*) north throughout South Carolina and eastern North Carolina to the Pamlico River. Also central Georgia and central Alabama (fig. 73).

7 a. Males with less than 40 subcaudals; females with less than 35 subcaudals; adults with proximal rattles wider than 3½mm. 8

7 b. Males with more than 40 subcaudals; females with more than 35 subcaudals; rattles very small, width less than 3½ mm. in adults. A pattern of about 40 black-edged, olive-gray diamonds on a gray-brown ground. **Crotalus stejnegeri**

The mountains of southeastern Sinaloa and western Durango in Mexico (fig. 71).

8 a. Outer edges of supraoculars not extended into raised and flexible hornlike processes (fig. 21). 9

8 b. Outer edges of supraoculars extended into raised and flexible hornlike processes distinctly pointed at the tip (figs. 22 and 23). Dorsal scales strongly keeled and with posterior bosses. Ground color cream, straw, pink, or light-gray, with a central series of square, brownish blotches, often with yellow or orange on the middorsal line. **Crotalus cerastes** *(Fig. 95).*

The deserts of the southwest including: California east of the Sierra Nevada and the southern California coastal ranges, from Lat. 37°30′ southward; Nevada south of Lat. 37°30′; west-central and southwestern Utah; Arizona south and west of the line Kingman—Miami—Nogales; extreme northwestern Sonora; the transmontane desert area of northeastern Baja California from the U. S. border south to Lat. 29°40′ (fig. 71). A species preferring sandy deserts but sometimes found on rock-strewn flats. (Note: In the Southwest the range of *cerastes* is popularly supposed to be considerably more extensive than

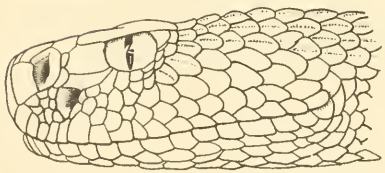

Fig. 21. Lateral head scales of *Crotalus (C. cinereous).*

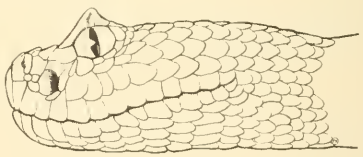

Fig. 22. *C. cerastes,* showing hornlike supraocular (lateral view).

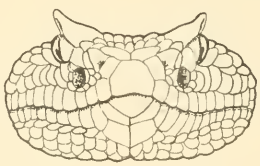

Fig. 23. *C. cerastes* (front view).

is here depicted, since in many areas all young rattlesnakes are termed "sidewinders", leading to confusion with the real *cerastes*. While further collecting may be expected to develop some range extensions, this most highly specialized of our desert snakes cannot possibly exist in some areas where it has been said to occur, but from which no authentic specimens have ever been forthcoming).

9 a. Tip of snout and canthus rostralis not raised into a sharp ridge (fig. 24); no central light line on rostral and mental. **10**

9 b. Tip of snout and canthus rostralis raised into a sharp ridge, by bending up of the outer edges of internasals and canthals (fig. 25); rostral and mental usually marked vertically by a narrow, light line on a red-brown ground (fig. 26). Body pattern of large, brown or red-brown blotches separated by narrow light areas, the blotches being often without definite outlines on the sides; tail pattern terminating in logitudinal bands rather than crossbars. **Crotalus willardi** *(Fig. 102).*

Highland areas from extreme southern Arizona to Zacatecas, Mexico including: the Santa Rita and Huachuca mountains in Arizona; and the Sierra Tarahumare and Sierra Madre in eastern Sonora, western Chihuahua, Durango, and western Zacatecas (fig. 72).

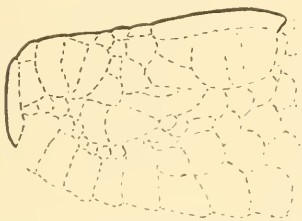

Fig. 24. Cross-section of *Crotalus* head *(C. m. mitchellii)*, showing absence of internasal ridge.

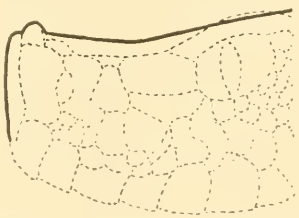

Fig. 25. Cross-section of *C. willardi* head, showing internasal ridge.

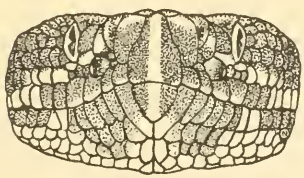

Fig. 26. Head of *C. willardi*, showing light line usually present on rostral and mental.

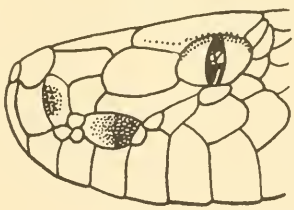

Fig. 27 *C. polystictus*, showing indentation on upper edge of prenasal.

10 a. Head width usually greater than 60 per cent of the length; prenasal not deeply indented by a lateral bulge in the first canthal (fig. 21); paired intercanthals, if present, not distinctly longer than wide. 11

10 b. Head long and narrow, maximum width less than 60 per cent of length; prenasal deeply indented by a lateral bulge in the first canthal (fig. 27); paired intercanthals longer than wide (fig. 28); usually 8 scales in two transverse rows on top of the head anterior to the supraoculars and intersupraoculars (maximum variation 6 to 10); dorsal pattern usually of parallel rows of dark-brown elliptical blotches, the major axes of which are longitudinal to the snake and with narrow gray-brown interspaces (fig. 29); ventral surface heavily mottled with dark-brown or black. **Crotalus polystictus**

The tableland of central Mexico from Zacatecas to Oaxaca including: southern Zacatecas, eastern Jalisco, Guanajuato, Michoacán, Distrito Federal, west-central Veracruz, Oaxaca, and probably the intervening states of Aguascalientes, Querétaro, Hidalgo, México, Morelos, Tlaxcala, and Puebla (fig. 69). Unverified reports from southern Jalisco and eastern Colima.

11 a. No paired dark vertebral stripes on the neck; or if present, not extending as much as 1½ head-lengths before meeting the first dorsal blotches; vertebral process less sharp and prominent; dorsal scales without such prominent posterior bosses.* 13

11 b. A pair of dark vertebral stripes 1 to 3 scales wide on the neck, bounding a lighter middorsal stripe about 3 scales wide, and extending posteriorly 1½ head-lengths or more before meeting the first dorsal blotches; spinous process sharp and ridge-like; posterior head scales and dorsal scales strongly keeled and with conspicuous posterior bosses; usually with only 4 and rarely with more than 6 large flat scales on the crown anterior to the supraoculars and intersupraoculars. **Crotalus durissus**

(For subspecies continue on to 12)

* There are rare instances of paired vertebral stripes in *viridis;* these can readily be differentiated from *durissus* by the presence of more than 6 scales in the internasal—prefontal area. Similarly occasional specimens of *durissus* occur in which the characteristic anterior paravertebral stripes are replaced by blotches. As far as we now know any rattlesnake from Central or South America should be classified as *durissus,* except that *unicolor* may occur in Nicaragua.

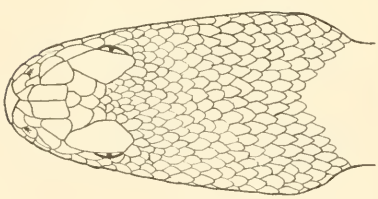

Fig. 28. *C. polystictus,* showing paired and elongated intercanthals.

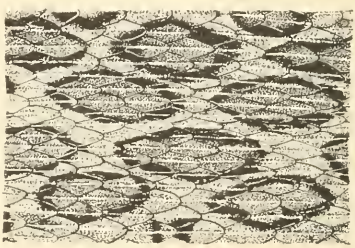

Fig. 29. Dorsal pattern of *C. polystictus.*

12 a. Light scale rows (one scale wide), laterally bounding the dark paravertebral stripes (or dorsal blotches) in strong color-contrast with the next scales below on the sides (fig. 30). A pattern of brown dorsal diamonds on a brown ground color, without strong contrast between the dorsal and lateral areas.

Crotalus durissus terrificus

(Fig. 75).

South America and eastern Central America including: Argentina, Uruguay, Paraguay, Brazil, Bolivia, eastern Peru, eastern Ecuador, the Guianas, Venezuela, Colombia, and central and eastern Costa Rica where there is intergradation with *C. durissus durissus* (figs. 65 and 66). Presence in Panama and Canal Zone somewhat doubtful.

12 b. Light scale rows (one scale wide), laterally bounding the dark paravertebral stripes (or dorsal blotches) but little or no lighter than the lateral areas next below (fig. 31). A pattern of dark-brown or black dorsal diamonds (usually with light centers) in strong contrast to the cream, yellow, gray, or light-brown ground color of the sides.

Crotalus durissus durissus

(Fig. 74).

Southern Mexico and Central America including: the Mexican states of Michoacán, Guerrero, Distrito Federal, central Puebla, central and southern Veracruz, Oaxaca, Tabasco, Chiapas, Campeche, Yucatán, and probably also Morelos, México, Tlaxcala, and Quintana Roo; Guatemala, British Honduras, Honduras, El Salvador, and Nicaragua (fig. 66). The area of intergradation with *C. durissus terrificus* seems to be approximately central Costa Rica, although the change is so gradual that specimens between Honduras and Panama may be difficult to allocate, the pattern being somewhat dependent on altitude.

13 a. Upper preocular not split vertically; or, if split,* the anterior section not conspicuously higher than the posterior and not curved over the canthus rostralis in front of the supraocular; prenasal not

* As is frequent in *mitchellii* and occasional in *triseriatus*.

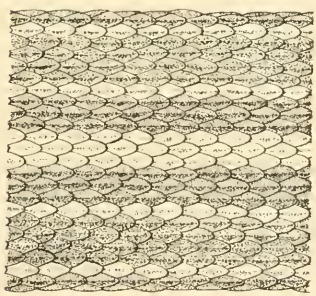

Fig. 30. Dorsal neck pattern of *C. d. terrificus.*

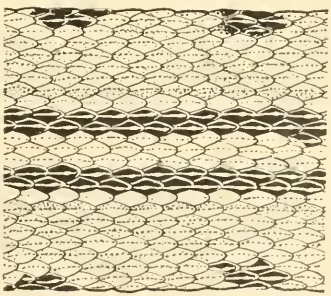

Fig. 31. Dorsal neck pattern of *C. d. durissus.*

curved under the postnasal (fig. 21); the pattern not of widely separated crossbars or rings. **15**

13 b. Upper preocular split vertically, the anterior section being higher than the posterior and curved over the canthus rostralis in front of the supraocular; prenasal curved under the postnasal (fig. 32); usually a pattern of widely separated crossbars (fig. 33).
Crotalus lepidus
(For subspecies continue on to 14).

14 a. A dark stripe passing backward from the eye to the angle of the mouth (fig. 32); dorsal pattern of crossbars often not strongly differentiated from the ground color; ventral surface mottled. A pattern of 13 to 22 brown or black blotches or crossbars on a punctate background of gray, brown, or pink flecked with gray, the blotches being separated by a much greater distance (neglecting rudimentary* or obsolescent blotches which are often present) than the longitudinal extent of the blotches; tail usually pink or reddish, crossed by 4 or less widely separated brown rings.
Crotalus lepidus lepidus
(Fig. 98).

West Texas and northeastern Mexico including: the trans-Pecos region of Texas (especially the Davis and Chisos mountains, but excluding the El Paso area, where it is replaced by *C.l. klauberi*), and Valverde, Real, and Maverick counties; Coahuila, northern San Luis Potosí, and probably northern Zacatecas (fig. 69).

14 b. No dark postocular stripe; dorsal pattern of crossbars sharply contrasting with the ground color; ventral surface punctated. A pattern of 14 to 21 dark reddish-brown, or black blotches, or crossbars on a background of green, blue-green, or blue-gray, the blotches being separated by a much greater distance than their longitudinal extent (fig. 33); tail usually cream or pink, crossed by 4 or less widely separated brown rings. A subspecies preferring mountains.
Crotalus lepidus klauberi
(Fig. 99).

Southeastern Arizona, southern New Mexico, the El Paso area in Texas, and north-central Mexico including: the Santa Rita, Huachuca,

* Occasionally these are almost as evident as the fundamental bars thus producing a pattern of closely adjacent bands.

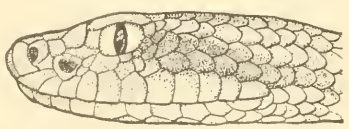

Fig. 32. *C. l. lepidus,* showing split upper preocular and prenasal curved under postnasal.

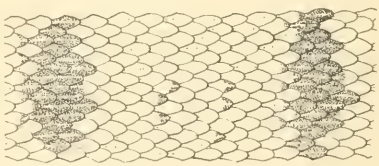

Fig. 33. *C. l. klauberi;* dorsal pattern.

Dragoon, and Chiricahua mountains of southeastern Arizona; the Franklin, Magdalena, Pinos Altos, Mimbres, Animas, Big Hatchet, and Dog mountains of southern New Mexico; El Paso County, Texas; and mountain areas in the Mexican states of Chihuahua, Durango, southern Zacatecas, Aguascalientes, eastern Nayarit, and northern and eastern Jalisco (fig. 69).

15 a. Prenasals in contact with rostral (fig. 34); upper preocular not divided, or if divided (as in a few *triseriatus*), the loreal conspicuously longer than high. **17**

15 b. Prenasals usually separated from the rostral by small scales or granules (fig. 35); upper preoculars often divided, horizontally, vertically, or both (fig. 36); rostral usually wider than high; a pattern of dorsal blotches essentially comprising aggregations of punctations. **16**

16 a. Head smaller; length of head contained in adult body length more than 24 times; original rattle-button (fig. 11), if present, more than 7.5 mm. wide. A pattern of dark-gray or brown, punctated blotches on a gray or tan background.

Crotalus mitchellii mitchellii
(Fig. 91).

Distrito del Sur of Baja California, Mexico, intergradation with *C. mitchellii pyrrhus* occurring approximately along the border of the two districts; also the islands of Ceralvo, Espíritu Santo, San José (Gulf Coast), and Santa Margarita (Pacific Coast). Fig. 69.

16 b. Head larger; length of head contained in adult body length less than 24 times; original rattle-button, if present, less than 7.5 mm. wide. A pattern of red, gray, brown, or black, punctated blotches on a cream, tan, buff, gray, pink, salmon, fawn, or brown back-

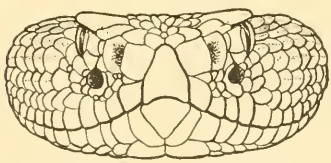

Fig. 34. Head scales of *Crotalus;* front view *(C. cinereous).*

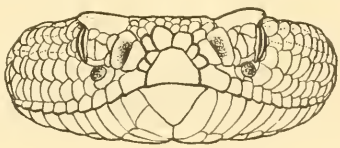

Fig. 35. *C. m. pyrrhus;* front view, showing separation of rostral from prenasals; also rostral wider than high.

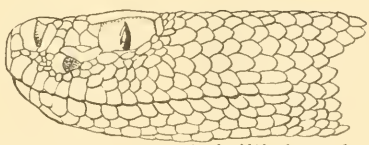

Fig. 36. *C.m. mitchellii;* lateral view showing split upper preocular.

ground; often with posterior black tips on some dorsal scales between blotches. **Crotalus mitchellii pyrrhus** *(Fig. 92).*

Southern California, western Arizona, and northern Baja California including the following: California south of the line Barstow—Ivanpah (approximate line of intergradation with *C.m. stephensi*) and east of Long. 118° (but absent from the San Gabriel Mountains and the coastal plain); the southern tip of Nevada; Baja California south to the northern boundary of Distrito del Sur (where intergradation with *mitchellii mitchellii* is to be expected); Isla Angel de la Guarda; extreme northwestern Sonora; west-central and southwestern Arizona, inside the line Peach Springs—Williams—Casa Grande—Ajo (fig. 69). A species preferring rocky habitats.

17 a. Tail of alternating black, and light ash-gray rings, both colors being in sharp contrast with the posterior body color (fig. 37), which may be gray, dark-gray, cream, pink, red, red-brown, or olive-brown.* **18**

17 b. Tail not of alternating black, and light ash-gray rings in strong color-contrast to the body color immediately anterior to the tail. **23**

18 a. Dark and light tail rings of approximately equal width (fig. 37); postocular light stripe, if present, intersects the supralabials from 1 to 3 scales anterior to the angle of the mouth (fig. 38); minimum scales between supraoculars 3 or more (fig. 14); no definite line of demarcation between the scales in the frontal and prefrontal areas; proximal rattle black. **Cinereous group 19**

* Many other species of rattlers have barred tails but it is characteristic of the *cinereous* group that there is a sharp transition in color at the beginning of the tail, whereas in the others there is no sharp contrast between the posterior body rings and the anterior tail rings. The *cinereous*-type tail has the appearance of having been attached to the wrong snake.

Fig. 37. Tail pattern of *cinereous* group.

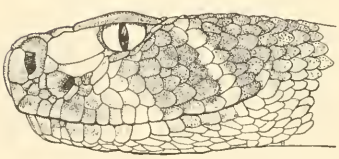

Fig. 38. *C. cinereous;* lateral head marks.

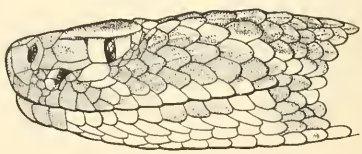

Fig. 39. *C. scutulatus;* lateral head marks.

18 b. Dark tail rings narrower than light; postocular light stripe, if present, passes backward above the angle of the mouth (fig. 39); minimum scales between the supraoculars rarely more than 2; a definite division line or suture between the scales in the frontal and prefrontal areas (fig. 40); lower half of proximal rattle light in color. A pattern of brown hexagons or diamonds on a green, olive-green, or brown background; light scales bordering the dark diamonds are unicolor, it being characteristic of this species that the blotch edges follow the scales and do not cut them.

Crotalus scutulatus

(Fig. 84).

From the Mojave Desert in California southeastward to south-central Mexico including: Kern, Los Angeles (Antelope Valley), and San Bernardino counties in California but only eastward of the Tehachapi, San Gabriel, and San Bernardino mountains; the desert valleys of Lincoln and Clark counties, Nevada; extreme southwestern Utah; Arizona south and west of the line Williams—Safford; extreme southwestern New Mexico; trans-Pecos Texas; northeastern Sonora, Chihuahua, eastern Durango, southern Coahuila, southwestern Tamaulipas, Zacatecas, San Luis Potosí, and southeastward at least to Tlaxcala, no doubt including the intervening Mexican plateau states of Guanajuato, Querétaro, and Hidalgo (fig. 66).

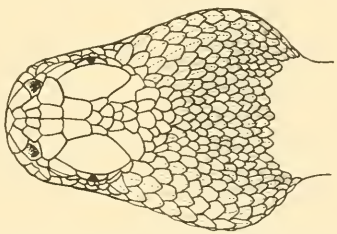

Fig. 40. Dorsal head scales of *C. scutulatus* showing paired inter-supraoculars.

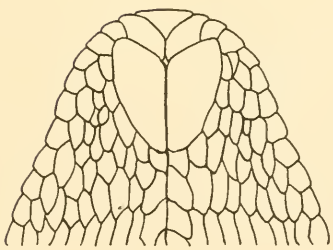

Fig. 41. Chin shields of *Crotalus;* first infralabials undivided.

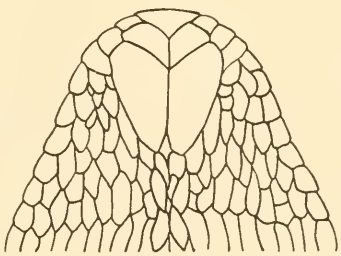

Fig. 42. Chin shields of *Crotalus*; first infralabials divided.

19 a. First infralabials usually not divided transversely (fig. 41); general color cream, buff, gray, or gray-brown (sometimes pink or red in central Arizona or New Mexico); dark punctations conspicuous in markings. **20**

19 b. First infralabials usually divided transversely (fig. 42);* general color pink, red, brick-red, red-brown, or olive-brown; dark punctations weakly in evidence or absent from markings. **21**

20 a. Upper preocular usually not in contact with the postnasal and no upper loreal present (fig. 43); head smaller in proportion to body. Pattern of dark-brown, punctated diamonds with lighter centers on a gray background, and with light borders of the diamonds often absent laterally. **Crotalus tortugensis** *(Fig. 81).*

Tortuga Island in the Gulf of California (fig. 67).

20 b. Upper preocular usually in contact with the postnasal (fig. 44), or such contact prevented by an upper loreal (fig. 45); head proportionately larger. Pattern of brown dorsal diamonds consisting

* A considerable proportion of California *cinereous* have divided first infralabials and one must employ the pattern criteria to judge California specimens or he will be improperly led to course 21 instead of 20. The blotches of *cinereous* are always strongly punctate, those of *ruber* almost unicolor.

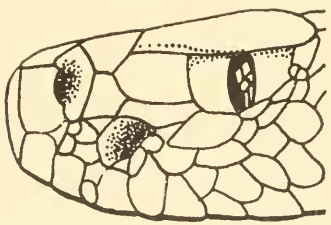

Fig. 43. Snout of *Crotalus;* no contact between postnasal and preocular.

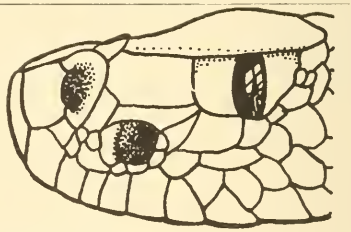

Fig. 44. Snout of *Crotalus;* contact between postnasal and preocular; also between prenasal and first supralabial.

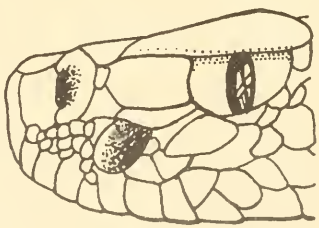

Fig. 45. Snout of *Crotalus;* upper loreal present; no contact between prenasal and first supralabial.

of aggregations of punctations on a cream, buff, gray, gray-brown, or (rarely) reddish background. **Crotalus cinereous** *(Figs. 80 and 108).*

From Arkansas and Texas south to central Mexico and west to California including the following: extreme southeastern Missouri; northeastern, central, and west-central Arkansas; western and southern Oklahoma; Texas (except the Panhandle and east of Long. 95°); New Mexico south of Lat. 36° but not including the mountains of the central-west; Arizona south and west of the line Ash Fork—Clifton; the southern tip of Nevada; the desert areas of Riverside and Imperial counties, California, touching extreme eastern San Diego County; extreme northeastern Baja California; and the Mexican states of Sonora, Chihuahua, Coahuila, Nuevo Léon, Tamaulipas, San Luis Potosí, and the northern tip of Veracruz; also Tiburón Island in the Gulf of California; probably present in northeastern Durango and northern Zacatecas (fig. 67). Has been introduced and seems to have gained a foothold in Vernon County, Wis.

21 a. Intergenials usually absent (fig. 41); prenasals generally in contact with first supralabials (fig. 43); tail rings complete, or broken only on the middorsal line; adults exceed 900 mm. **22**

21 b. A pair of intergenials usually present (fig. 46); generally no contact between the prenasal and first supralabial (fig. 45); dark tail rings often broken laterally; size smaller, adults rarely exceeding 900 mm. A pattern of red, circular, and ill-defined blotches on a pinkish ground color. **Crotalus exsul**

Cedros (Cerros) Island off the Pacific Coast of Baja California (fig. 67).

22 a. General color pink, red, brick-red, or red-brown; usually no light areas present within the diamonds; light preocular stripe 1 or 2 scales wide,* dull and often obscure; supraocular light crossbars usually absent. A pattern of reddish, almost unicolor, diamonds on a pinkish ground color. **Crotalus ruber** *(Fig. 83).*

* Preferably to be determined at the second row of scales above the supralabials if the scales are regular.

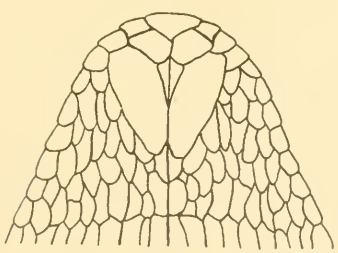

Fig. 46. Chin shields of *Crotalus*; intergenials present.

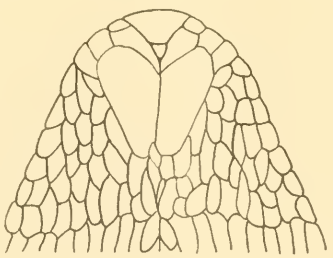

Fig. 47. Chin shields of *Crotalus*; submental present.

The Californias from Lat. 34° to Lat. 26° including southeastern Los Angeles County, Orange County (excluding the coastal plain) Riverside County (west of the desert), San Diego County, and extreme southwestern Imperial County, California; Baja California, Mexico, from the northern border to the vicinity of Comondú, but excluding the deserts of the north lying east of the Sierra Juárez and Sierra San Felipe; also the adjacent Gulf of California islands of Angel de la Guarda, Pond, South San Lorenzo, San Marcos, and Monserrate (fig. 67).

22 b. General color brown, olive-brown, or yellow-brown; light areas usually present within the diamonds; light preocular stripe 3 or more scales wide, bright and conspicuous; supraocular light crossbars usually in evidence. Dorsal pattern of brown or olive-brown blotches on a buff background. **Crotalus lucasensis** *(Fig. 82).*

The southern part of the peninsula of Baja California, Mexico, from Lat. 25°30′ to the Cape; the adjacent islands of Santa Margarita and San José (fig. 67).

23 a. Two internasals (fig. 48). **29**

23 b. More than two internasals i. e. scales between nasals, and in contact with rostral, regardless of size or position* (fig. 49). **Crotalus viridis**

(For subspecies continue on to 24).

24 a. Light postocular stripe 1 or 1½ scales wide and clearly outlined (fig. 50); body blotches commonly subrectangular, with even edges and usually with a narrow light border (fig. 52). **25**

* I have already stated (p. 198) that the internasal criterion will occasionally fail properly to key out *viridis* and its subspecies. It may be noted at this point that if the snake is from California west of the Sierra Nevada, from Oregon, Washington, British Columbia, northern Nevada, Idaho, Montana, Alberta, Saskatchewan, Wyoming, Utah (except the extreme southwest), Colorado, the Dakotas, western Nebraska, or western Kansas one may safely take course 24 even though the snake have only 2 internasals.

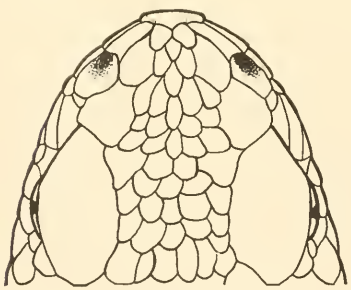

Fig. 48. Crown of *Crotalus* showing two internasals.

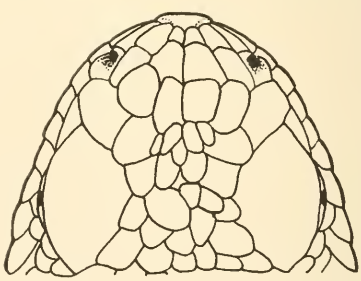

Fig. 49. Crown of *Crotalus* showing four internasals.

24 b. Light postocular stripe 2 or more scales wide, often indefinite or absent (figs. 10 and 51); body blotches, if in evidence, commonly diamonds, ellipses, or if rectangles, with edges rough or serrated, and often without narrow light borders. 26

25 a. Color usually green or olive-green; less often olive-brown or brown; scale-rows 27 or 25; dorsal scale rows at the center of the tail 13 or more; adult size exceeding 850 mm. A pattern of even-edged dark-brown rectangular or subhexagonal blotches usually surrounded by a thin light line. **Crotalus viridis viridis** *(Fig. 85).*

The Great Plains from Long. 97° to the Rocky Mountains and from southern Canada to extreme northern Mexico including the following: southwestern Saskatchewan (south of the South Saskatchewan River and west of Long. 107°30′); southeastern Alberta (south of the Red Deer River and east of Long. 113°); Montana, except the higher mountains in the west; the Lemhi Valley in Idaho; Wyoming east of the Rockies; Colorado (except in the higher mountains, and in the basins of the Colorado and Green rivers west of the Continental Divide); extreme southeastern Utah and northeastern Arizona (San Juan River basin); New Mexico, except the mountains of the west-center; extreme northeastern Sonora and northern Chihuahua near the U. S. boundary; southwestern North Dakota (west of the Missouri River but including the first tier of counties on the eastern bank); western South Dakota (limiting counties Hand and Jerauld); western Nebraska; central and western Kansas (limiting counties Riley and Geary); Oklahoma west of Woods and Custer counties; Texas west of Long. 97° and north of Lat. 30° (fig. 68). The rattler of the western Mississippi basin plains.

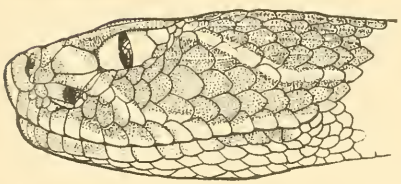

Fig. 50. Lateral head pattern of *C. v. viridis.*

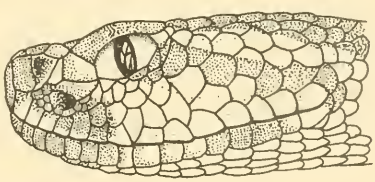

Fig. 51. Lateral head pattern of *C. v. oreganus.*

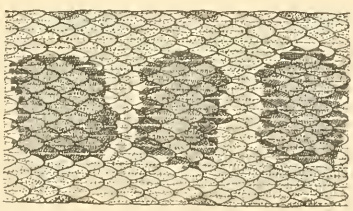

Fig. 52. Dorsal pattern of *C. v. viridis.*

25 b. Color, pink, red, or red-brown;* scale rows 25 or 23; dorsal scales at the center of the tail 12 or less; adult size rarely exceeding 650 mm. **Crotalus viridis nuntius** *(Fig. 86).*

Northeastern and north-central Arizona from the New Mexican line to Cateract Creek including the following: the basin of the Little Colorado River; the southern part of the Apache Indian Reservation; the Hopi Indian Reservation; and the Coconino Plateau, from the south brink of the Grand Canyon south to U. S. Highway 66 (fig. 68).

26 a. Color darker, not straw, cream, or yellow; adult size larger, over 650 mm. 27

26 b. Color straw, cream, or yellow; blotches often only faintly in evidence or obsolete in adults; adult size smaller, usually under 650 mm. **Crotalus viridis concolor** *(Fig. 89).*

The basins of the Colorado and Green rivers including: a small area in southwestern Wyoming; Utah east of Long. 111° and north of the San Juan River (intergradation with *viridis viridis* is indicated in this river valley); western Mesa, southwestern Delta, and northern Montrose counties in western Colorado (fig. 68).

27 a. Adult color other than vermilion or salmon; body blotches in evidence, or body black. 28

27 b. Adult color vermilion or salmon; body blotches tending toward obsolescence in adults. **Crotalus viridis abyssus** *(Fig. 87).*

The Grand Canyon of the Colorado River, Grand Canyon National Park, Arizona from the north to the south rim (fig. 68).

28 a. Ground color lighter, usually buff or drab; body blotches occupy less or but little more longitudinal space than interspaces; secondary series of lateral blotches little in evidence; a pattern of dark-brown dorsal blotches (often with light centers) on a buff or drab ground color. **Crotalus viridis lutosus** *(Fig. 88).*

The Great Basin between the Rocky Mountains and the Sierra Nevada including: Idaho south of Lat. 44°; Utah west of Long. 111°; Arizona north and west of the Colorado River and the north rim of the Grand Canyon; all of Nevada except Esmeralda, southern Nye, and Clark counties; California, east of the Sierra Nevada, from Lower Klamath Lake south to below Mono Lake; Oregon south and east of the line Upper Klamath Lake—Fort Rock—Burns—Council (Idaho), this being the approximate line of intergradation with *C.v. oreganus* (fig. 68).

28 b. Ground color darker, usually dark-gray, olive, brown, or black; dark-brown or black dorsal blotches (usually diamonds or hexagons) occupying considerably more longitudinal space than the

* Specimens from the plateau south of the Grand Canyon, Arizona, are usually greenish or grayish, but should be referred to this subspecies.

interspaces; a secondary series of lateral blotches conspicuously in evidence. Some mountain specimens nearly uniform black, only patches of yellow scales representing the interspaces on the mid-dorsal line. **Crotalus viridis oreganus** *(Figs. 90, 109, and 110).*

The Pacific slope from British Columbia to central Lower California including the following: the basins of the Fraser and Okanogan Rivers in south-central British Columbia, south of Lat. 51° and between Long. 119° and 122°, Washington east of the Cascade Mountains; the western edge of Idaho from Coeur d'Alene south to Lat. 44°; Oregon west of the line Upper Klamath Lake—Fort Rock—Burns—Council (this being the approximate line of intergradation with *lutosus*) but absent from northwestern Oregon west of the Cascades and from southwestern Oregon immediately contiguous to the coast;* all of California west of the Sierra Nevada (including these mountains), but excluding a narrow coastal fringe in the extreme northwest and the entire desert (transmontane) area of the southeast; the west coast and mountains of Baja California from the U. S. border south to Punta María (Lat. 29°); the mountain areas of central and southern Arizona south of the line Peach Springs—San Francisco Peak—Springerville but not including the desert areas of the southwest; the mountains of extreme west-central New Mexico (vicinity of Steeple Rock) and of extreme northern Sonora;† the Pacific Coast islands—Morro Rock, Santa Catalina, and Los Coronados (fig. 68).

29 a. No vertical light line on the posterior edge of the prenasals and first supralabials. **30**

29 b. A vertical light line on the posterior edge of the prenasals and first supralabials (fig. 53). A pattern of black, or dark-brown diamonds, with lighter centers, surrounded by single rows of yellow scales on a dark-brown background. **Crotalus adamanteus** *(Fig. 79).*

The coastal plains of the following southeastern and gulf states: North Carolina south of Albemarle Sound; South Carolina; Georgia; all

* An occasional specimen is found at the river mouths, evidently carried down by floodwater.

† The Arizona—Sonora range of *oreganus* does not conjoin the coastal range; there is an unoccupied desert gap between. Nevertheless I do not find consistent differences warranting the recognition of the Arizona form as a separate subspecies, *C. v. cerberus*.

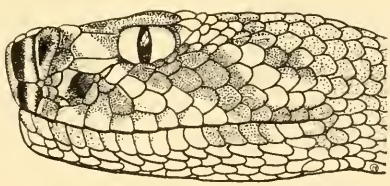

Fig. 53. *C. adamanteus,* showing vertical light marks on prenasal and first supralabial.

of Florida, with many of the adjacent keys; Alabama; Mississippi; and extreme southeastern Louisiana (fig. 67). A lowland species.

30 a. Supraoculars not pitted, sutured, nor with broken outer edges (fig. 14). 31

30 b. Supraoculars pitted, sutured, or with outer edges broken (fig. 54). A pattern of buff, gray, brown, or deep red-brown blotches on a background of straw, tan, buff, brown, or gray; often with gray suffusions on the sides of head and body, and with black-tipped scales scattered on the dorsum particularly at blotch edges.

Crotalus mitchellii stephensi

(Fig. 93).

The mountain and rocky desert areas of east-central California and southwestern Nevada including: the eastern slopes of the Sierra Nevada from southern Mono County to southern Kern County and eastward in California through the desert mountain ranges to the Nevada line; Nevada west and south of the line Hawthorne—Tonopah —St. Thomas. Intergradation with *C.m. pyrrhus* occurs approximately along the line Barstow—Ivanpah, which thus constitutes the southern limit of *stephensi* (fig. 69). A rock inhabiting form.

31 a. No distinct and evenly-outlined light supraocular crossbars curving forward inwardly; scales on the crown and frontal area smooth and flat. 32

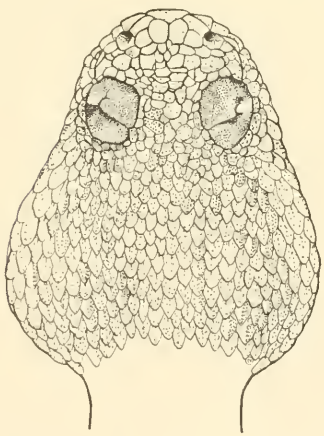

Fig. 54. *C. m. stephensi,* showing sutured supraoculars.

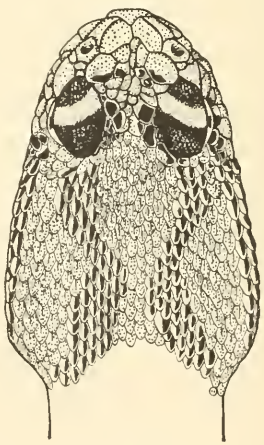

Fig. 55. Dorsal head pattern, *C. enyo,* showing light marks on supraoculars curving forward inwardly.

31 b. Distinct and evenly-outlined light supraocular crossbars curving forward inwardly (fig. 55); scales on the crown and frontal area rough, ridged, or knobby; outer edges of the supraoculars raised above the crown (particularly evident in life) forming a depression in the frontal area; dorsal scales sharply keeled and with prominent posterior bosses; ridged spinous process sharply evident. A pattern of dark-brown blotches on a fawn background, usually with black in the lateral corners of the blotches at midbody.

Crotalus enyo

(Fig. 77).

The peninsula of Baja California, Mexico, from the Cape north to Lat. 30°, together with the adjacent islands of San Francisco, Carmen, and Partida, in the Gulf of California, and Santa Margarita on the Pacific side (fig. 66).

32 a. General color dark and with conspicuous blotches 33

32 b. General color white, cream, or yellow, with grayish tail; a mid-dorsal light line faintly in evidence, especially at the neck; paired apical scale-pits rendered conspicuous (particularly near the tail) by gray dots. **Crotalus unicolor***

Aruba Island, Dutch West Indies, off the coast of Venezuela (fig. 65).

33 a. Head larger; head length contained less than 25 times in adult body length; proximal rattle width contained in head length more than 2½ times. 34

33 b. Head notably small for a rattlesnake; head length in adults contained in body length (over-all) 25 times, or more; proximal rattle width contained in head length less than 2½ times; pattern

* Not to be confused with albino specimens of other species (fig. 111).

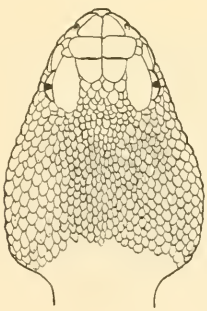

Fig. 56. *C. molossus,* showing enlarged scales in anterior part of frontal area.

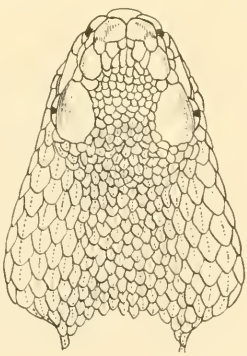

Fig. 57. *C. horridus,* showing lack of enlarged scales in frontal area.

a series of cross-rings or blotches comprising brown punctations on a pink, buff, or gray ground. **Crotalus tigris** *(Fig. 94).*

The rocky desert foothills of south-central Arizona, and northeastern and central Sonora, from the vicinity of Phoenix, Arizona, via Tucson, to Guaymas, Sonora, Mexico, including the following Arizona mountain ranges: Phoenix, Salt River, Estrella, Santa Catalina, Tucson, Coyote, Baboquivari (Verde), Sierrita, and Santa Rita (fig. 69). A rock inhabiting form.

34 a. Usually a definite division between the scales in the frontal and the prefrontal areas; scales in the anterior part of frontal area larger than those behind (fig. 56); anterior body pattern not in chevron-shaped bands or not all black. 36

34 b. No definite division or continuous suture between the scales in the frontal and the prefrontal areas; scales in the anterior part of frontal area not conspicuously larger than those behind (fig. 57); normal pattern a series of chevron-shaped crossbands sometimes broken (fig. 58), or with the body all black. **Crotalus horridus** *(For subspecies continue on to 35).*

35 a. Dorsal scale rows usually 23; postocular dark stripe indistinct; no middorsal reddish-brown stripe evident anteriorly; sometimes entirely black. **Crotalus horridus horridus** *(Fig. 96).*

The northeastern and north-central United States including: all of the Atlantic states from southwestern Maine to southern Virginia, (possibly exterminated in Delaware); West Virginia; Ohio; central and eastern Kentucky; the mountains of western North Carolina, northwestern South Carolina, northern Georgia, central and eastern Tennessee, and extreme northern Alabama; Indiana; Illinois (except the southern tip); southwestern Wisconsin; extreme southeastern Minnesota; eastern and southern Iowa; Missouri (except the southeast corner); extreme southeastern Nebraska; Kansas (east of Long. 97°);

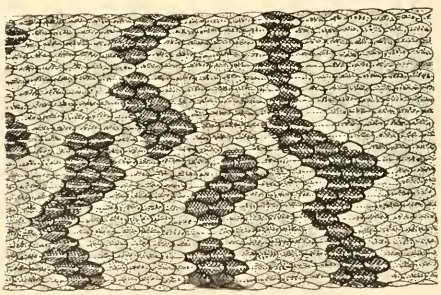

Fig. 58. Dorsal pattern of *C. h. horridus.*

the mountainous area of northwestern Arkansas; the eastern half of Oklahoma; north-central Texas (fig. 68). Originally present in southwestern Ontario but now said to be extinct.*

35 b. Dorsal scale rows usually 25; postocular dark stripe distinct and in contrast with the ground color; a middorsal reddish-brown or brown stripe evident anteriorly. **Crotalus horridus atricaudatus** *(Fig. 97).*

The lowlands of the South Atlantic and Gulf states and the lower Mississippi Valley including: eastern North Carolina; South Carolina; central and southern Georgia; Florida north of Lat. 29°30′; central and southern Alabama; Mississippi; extreme western Kentucky and Tennessee; Louisiana; southern and eastern Arkansas; extreme southeastern Missouri and southern Illinois; and Texas east of Long. 99° and north of Lat. 28° (fig. 68). On the Atlantic Coast this subspecies may range as far north as southern New Jersey.*

36 a. Dorsal scale rows usually less than 24; scale rows at the center of the tail 11 or less; ventrals rarely exceed 168; 1 or 2 scales between bottom-center of orbit and supralabials; usually a single loreal, longer than high (fig. 59); size small, adults rarely exceed 600 mm. **Crotalus triseriatus**

(For subspecies continue on to 37).

36 b. Dorsal scale rows usually exceed 24; scale rows at the center of the tail 12 or more; ventrals rarely less than 169; 3 or more scales between bottom-center of orbit and supralabials; usually more than one loreal, but if single, then higher than long (fig. 60); size large, adults over 600 mm. 38

37 a. Dorsal pattern a single series of dark-brown blotches, often edged with black and not sharply contrasting with the ground-color of

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* This rattlesnake, once indigenous to what are now the most populous areas of the United States, has largely been forced out of industrial and agricultural districts, but still remains in adjacent mountains and forests, where rocky or wooded retreats are available. Thus, its present range is intermittent and it is extinct in many areas over which it once ranged.

The boundaries between the subspecies *C.h. horridus* and *C.h. atricaudatus* are as yet not definitely determined. The division of the species *C. horridus* into these two subspecies considerably complicates the statement of the range so that it is difficult to visualize. For the species *C. horridus* as a whole the range can be more succinctly given thus: All of the states east of the Mississippi River except Michigan; also with a limited range in five other states, being confined to southwestern Maine, southern New Hampshire and Vermont, southern and western Wisconsin, and Florida north of Lat. 29°30′; it is possibly extinct in Delaware. West of the Mississippi the range includes: extreme southeastern Minnesota; eastern and southern Iowa; probably extreme southeastern Nebraska; Missouri; Kansas, east of Long. 97°; the eastern half of Oklahoma; Arkansas; Louisiana; and Texas east of Long. 99° and north of Lat. 28° (fig. 68). Of course to all of these areas the previous remarks concerning possible extermination in industrial and agricultural territories apply.

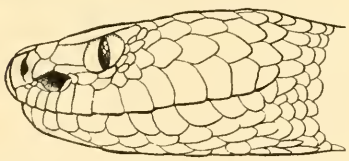

Fig. 59. Lateral head scales of *C. t. triseriatus.*

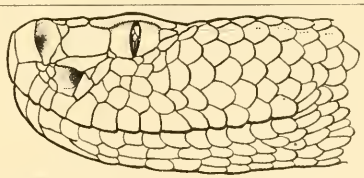

Fig. 60. Lateral head scales of *C. basiliscus.*

brown or dark-gray (fig. 61); usually 3 labials in contact with pit-border. **Crotalus triseriatus triseriatus** *(Fig. 100).*

The central Mexican plateau including: the higher areas in extreme southern Durango, Nayarit, southern Zacatecas, San Luis Potosí, southwestern Tamaulipas, Jalisco, Aguascalientes, Guanajuato, Querétaro, Hidalgo, Michoacán, México (state), Distrito Federal, Morelos, Guerrero, Tlaxcala, northern Puebla, and west-central Veracruz (fig. 71). Intergrades with *C.t. pricei* in southern Durango.

37 b. Dorsal pattern of two parallel rows of small brown blotches on a steel-gray ground color (fig. 62); usually 2 labials in contact with the pit-border. **Crotalus triseriatus pricei** *(Fig. 101).*

The mountains of southeastern Arizona and northwestern Mexico including: the Pinalino (Graham), Santa Catalina, Santa Rita, Huachuca, and Chiricahua mountains in Arizona; and the Sierra Tarahumare and Sierra Madre in eastern Sonora, western Chihuahua, and western Durango, intergrading with *C.t. triseriatus* in the southern part of the last named state (fig. 71).

38 a. Usually a single loreal; tail rings sharply contrasting in color. **Crotalus scutulatus** *(See under 18b).**

38 b. Usually two or more loreals; tail unicolor or with rings rather faint—not sharply contrasting. **39**

39 a. Tail often black, or with rings faintly in evidence against a dark background; vertebral process not conspicuous; tail shorter, approximately 7.1 per cent of body length (over-all) in the males and 5.8 per cent in females; subcaudals rarely more than 27 in males, or 23 in females; initial rattle-button (if present), over 5 mm. wide; body color primarily olive-green, or yellow-green with dark-brown blotches, often with a light interior blotch on each side of the center; blotch-bordering scales unicolor. **Crotalus molossus**

(For subspecies continue on to 40).

* This is the only species which is double-keyed, for *scutulatus* may or may not have a *cinereous*-like tail, and hence may take either course 17a or 17b.

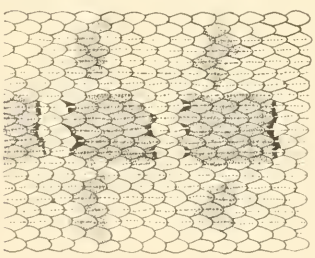

Fig. 61. Dorsal pattern of *C. t. triseriatus.*

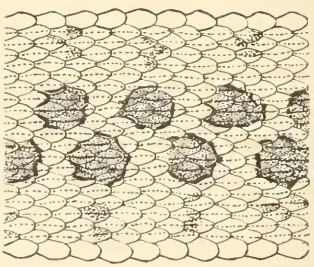

Fig. 62. Dorsal pattern of *C. t. pricei.*

39 b. Tail not black but with gray rings on a darker gray background; vertebral process prominent; tail longer, approximately 9.2 per cent of body length in the males and 7.4 per cent in the females; subcaudals in males rarely less than 28, or 23 in females; initial rattle-button (if present) less than 5 mm. wide; body pattern a series of red or red-brown diamonds (outlined with buff) on a pinkish background. **Crotalus basiliscus** *(Fig. 76).*

The west coast of Mexico between Lat. 17° and 25° including southern Sinaloa, Jalisco, Colima, and central Oaxaca certainly, and probably Nayarit, Michoacán, and Guerrero; restricted to the coast and adjacent higher areas (fig. 66).

40 a. Dark dorsal blotches (on the anterior half of the body) open on the sides and extending to the ventrals (fig. 63). A pattern of dark-brown blotches (often with a light interior blotch on each side of the center) on an olive-green or yellow-green ground color; blotch bordering scales unicolor.

Crotalus molossus molossus *(Fig. 78).*

From west Texas to Arizona and south in Mexico to northern Durango, including: the limestone area north and west of San Antonio, and trans-Pecos Texas; New Mexico southwest of the line Gallup—Otto—Carlsbad; Arizona, from the Grand Canyon and Little Colorado River south, but not including Mohave and Yuma counties; central and eastern Sonora, and western Chihuahua, intergrading with *C.m. nigrescens* in northern Durango; also San Esteban Island in the Gulf of California (fig. 70).

40 b. Dark dorsal blotches (on the anterior half of the body) closed laterally by light borders (fig. 64). Body color primarily olive-brown, or brownish-black, with dark-brown diamonds bounded by grayish or yellowish unicolored rows of light scales.

Crotalus molossus nigrescens

The tableland of Mexico from northern Durango (where it intergrades with *C.m. molossus*) south and east through Durango, southern Coahuila, Zacatecas, western San Luis Potosí, Aguascalientes, eastern Jalisco, Guanajuato, northern Michoacán, México (state), and Distrito Federal, to central Veracruz and southeastern Puebla (fig. 70).

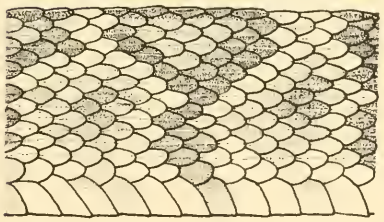

Fig. 63. Lateral pattern of *C. m. molossus.*

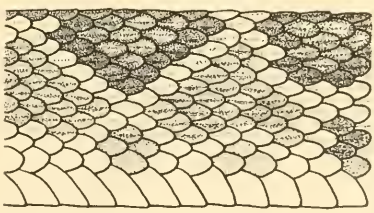

Fig. 64. Lateral pattern of *C. m. nigrescens.*

Fig. 65. Ranges of *Crotalus durissus terrificus* (in part) and *Crotalus unicolor*.

(The range of the South American rattlesnake is not known with accuracy, and this map is to be considered only a generalized indication of the area covered. Its presence in the central basin of the Amazon is doubtful).

Note. The grouping of the forms in the several maps is not necessarily an indication of relationship, the arrangement being primarily selected to reduce the required number of maps. However, subspecies of a single species always appear on the same map so that the approximate lines of intergradation can be seen, such lines being indicated by stars.

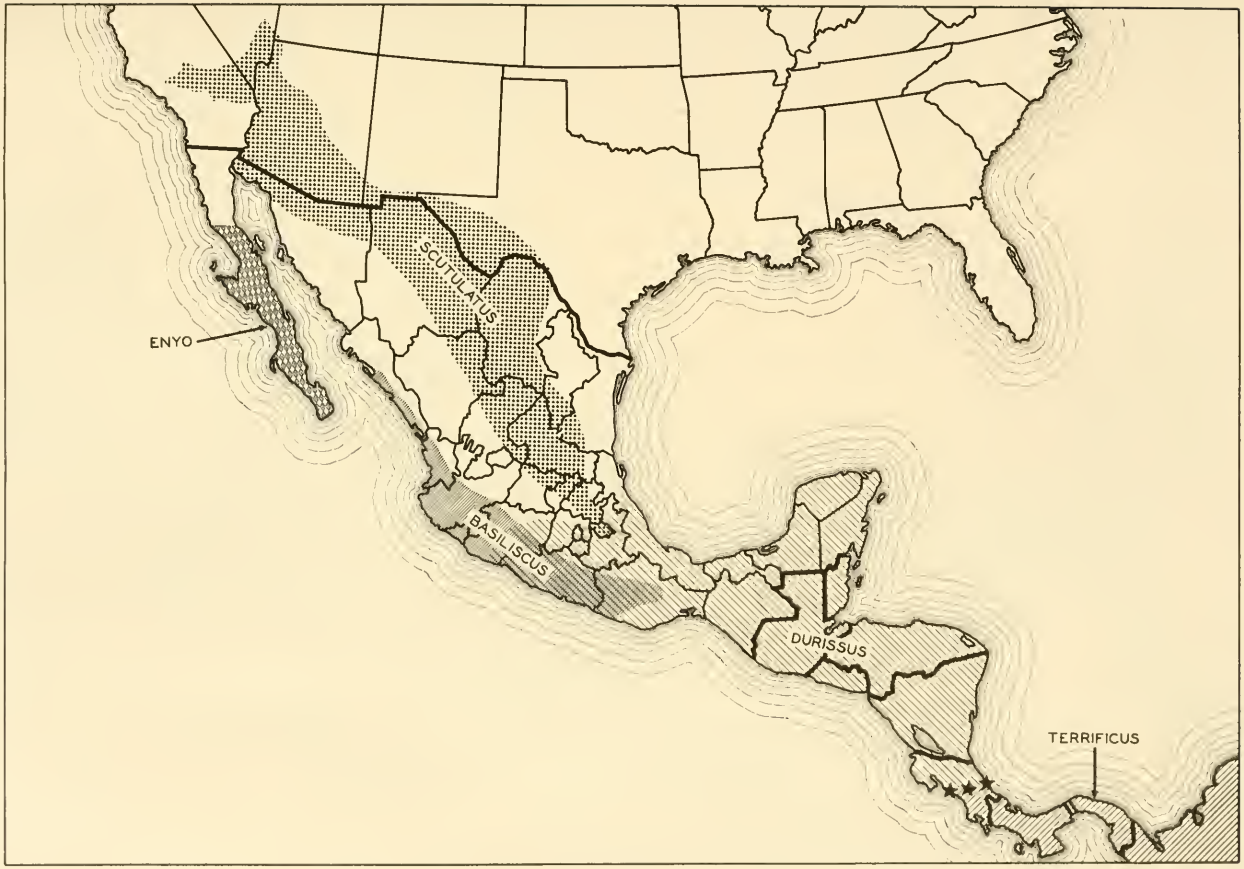

Fig. 66. Ranges of *Crotalus durissus durissus, C. d. terrificus, Crotalus basiliscus, Crotalus enyo,* and *Crotalus scutulatus.*

Although *C.d. terrificus* is indicated as ranging across Panama and the Canal Zone, its presence there is to be regarded as doubtful. For the South American range of this subspecies see fig. 65.

(Stars indicate approximate lines of intergradation between subspecies).

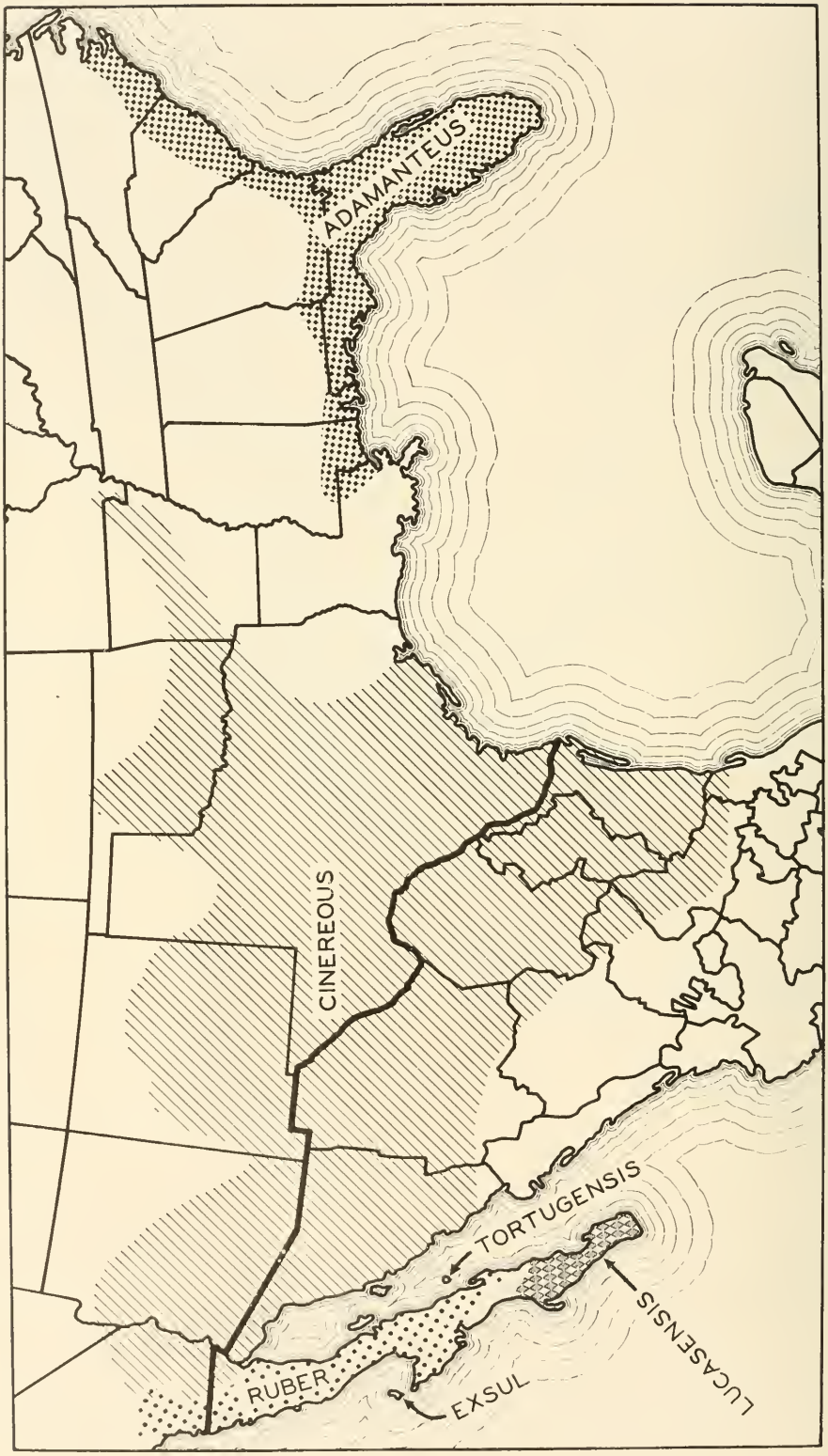

Fig. 67. Ranges of *Crotalus adamanteus*, *Crotalus cinereous*, *Crotalus tortugensis*, *Crotalus lucasensis*, *Crotalus ruber*, and *Crotalus exsul*.

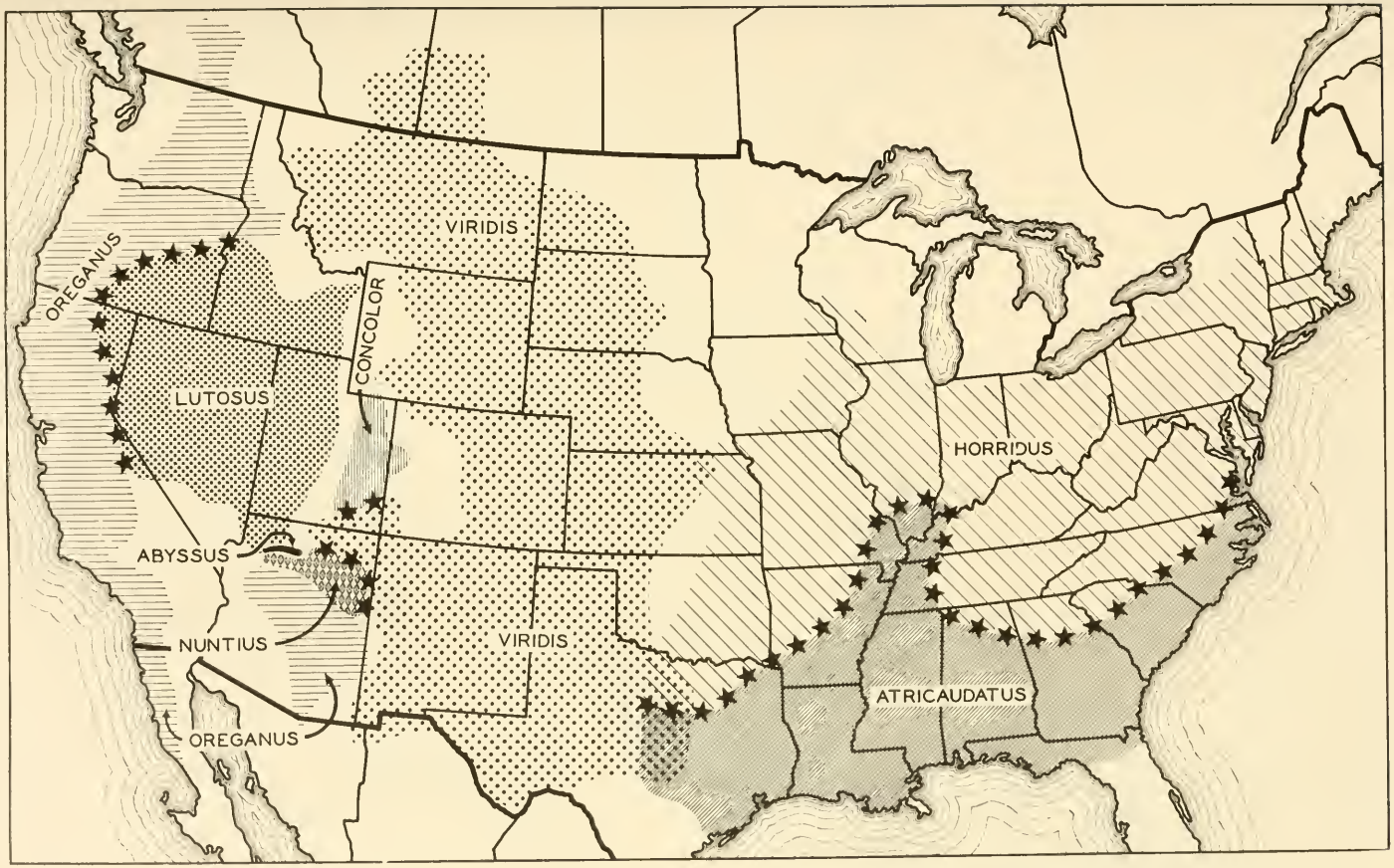

Fig. 68. Ranges of *Crotalus horridus horridus*, *C. h. atricaudatus*, *Crotalus viridis viridis*, *C. v. nuntius*, *C. v. abyssus*, *C. v. lutosus*, *C. v. concolor*, and *C. v. oreganus*.

C. v. abyssus intergrades with *C. v. nuntius* along the south rim of the Grand Canyon, and probably with *C. v. lutosus* along Kanab Creek. The small scale of the map prevents showing this by means of the usual stars, such as are used elsewhere to indicate areas of intergradation.

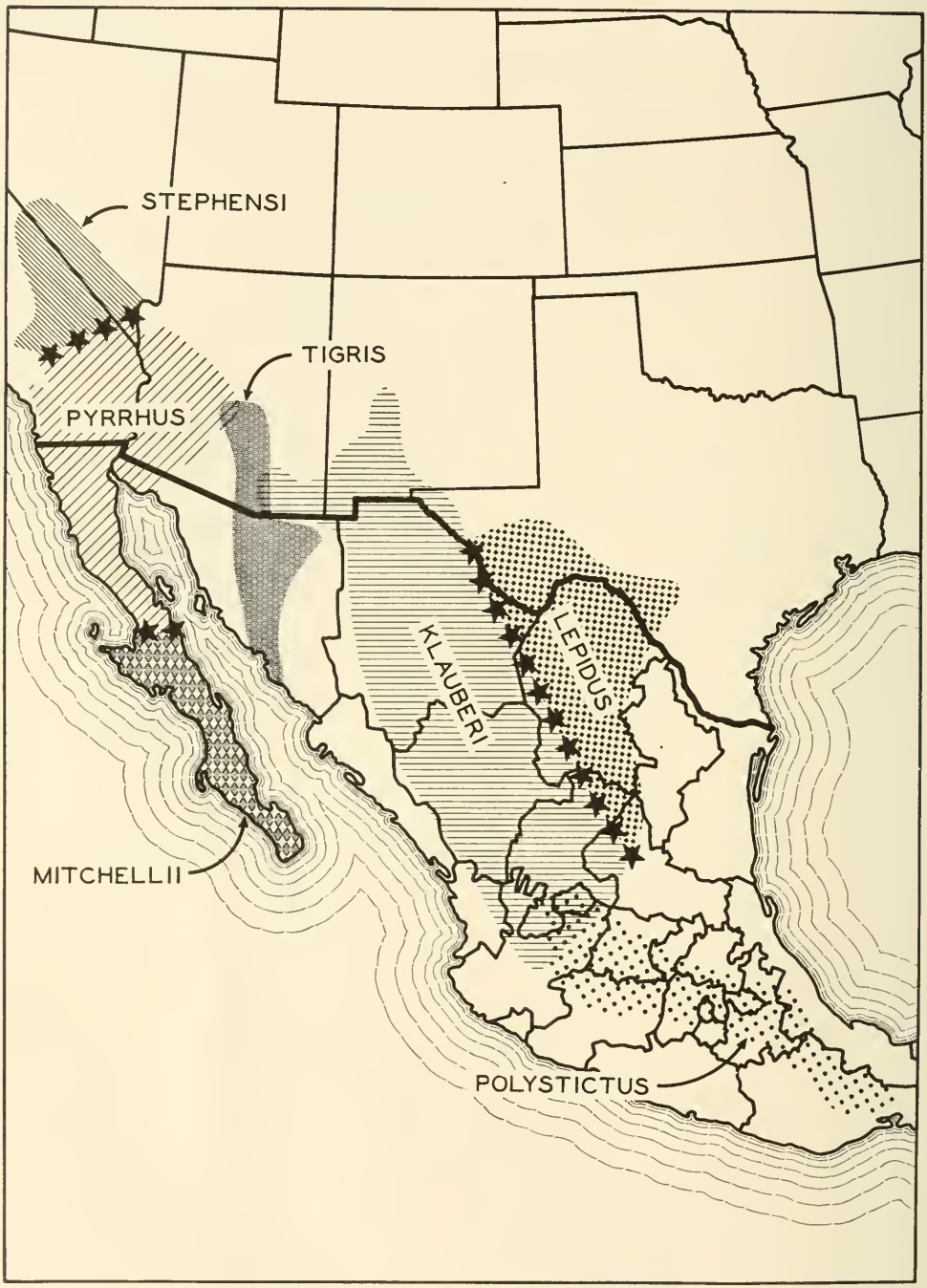

Fig. 69. Ranges of *Crotalus mitchellii mitchellii, C. m. pyrrhus, C. m. stephensi, Crotalus tigris, Crotalus lepidus lepidus, C. l. klauberi,* and *Crotalus polystictus.*

(Stars indicate approximate lines of intergradation between subspecies).

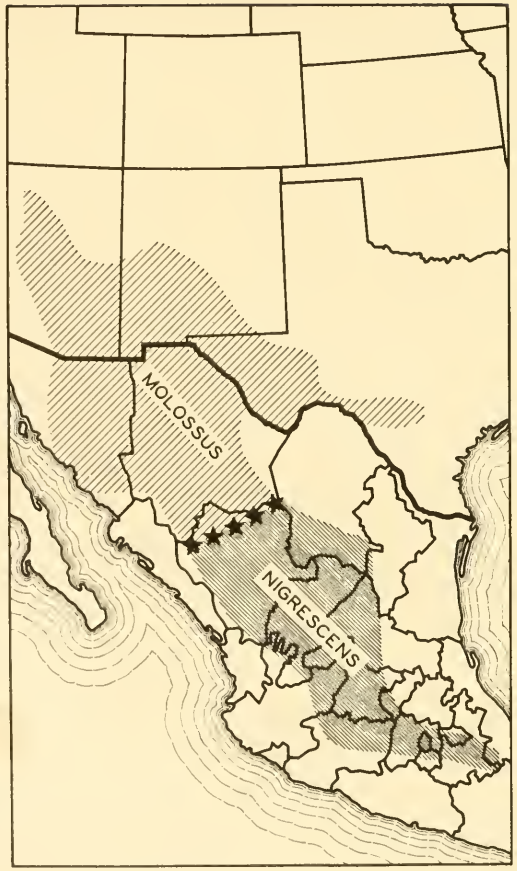

Fig. 70. Ranges of *Crotalus molossus molossus* and *C. m. nigrescens.*

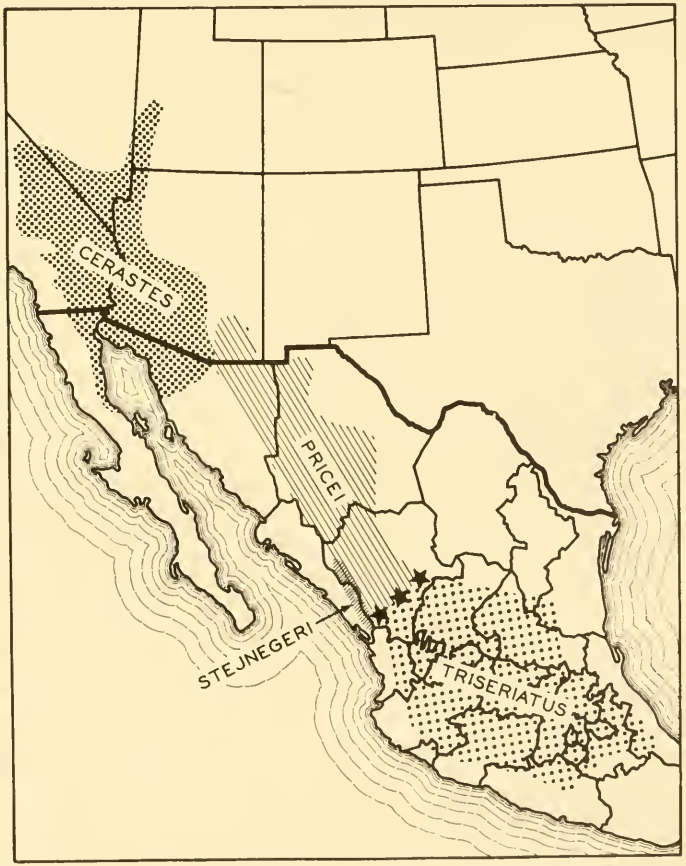

Fig. 71. Ranges of *Crotalus cerastes, Crotalus triseriatus triseriatus, C. t. pricei,* and *Crotalus stejnegeri.*

Fig. 72. Range of *Crotalus willardi.*

(Stars indicate approximate lines of intergradation between subspecies).

Fig. 73. Range of the genus *Sistrurus* comprising *Sistrurus ravus*, *Sistrurus miliarius miliarius*, *S. m. barbouri*, *S. m. streckeri*, *Sistrurus catenatus catenatus*, and *S. c. tergeminus*.

(Stars indicate approximate lines of intergradation between subspecies).

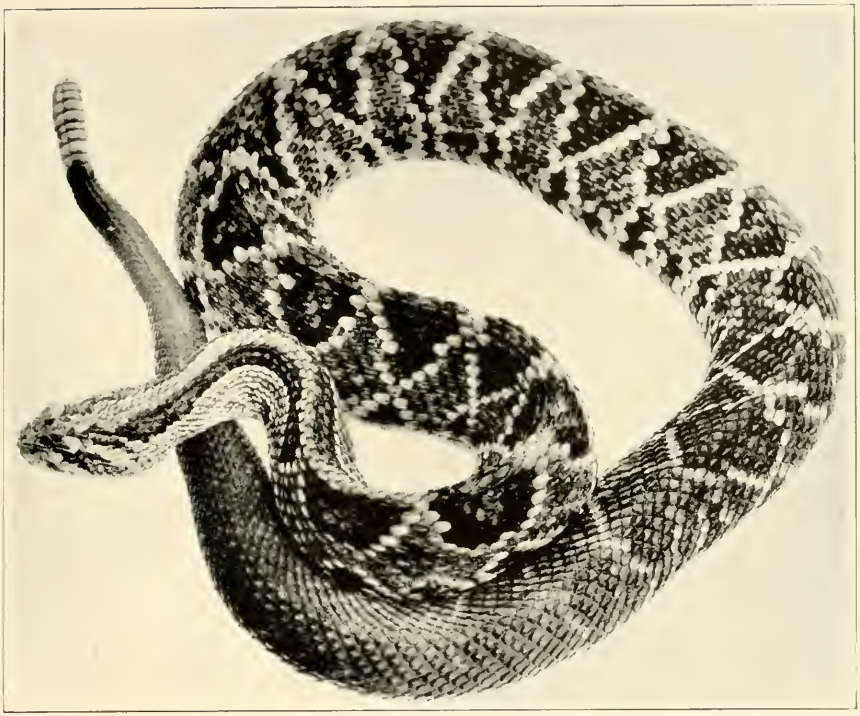

Fig. 74. *Crotalus durissus durissus.*
Central American Rattlesnake (12b).*
(Specimen from Vera Cruz, Mexico. West-coast specimens have less color in the lateral areas between dorsal blotches).

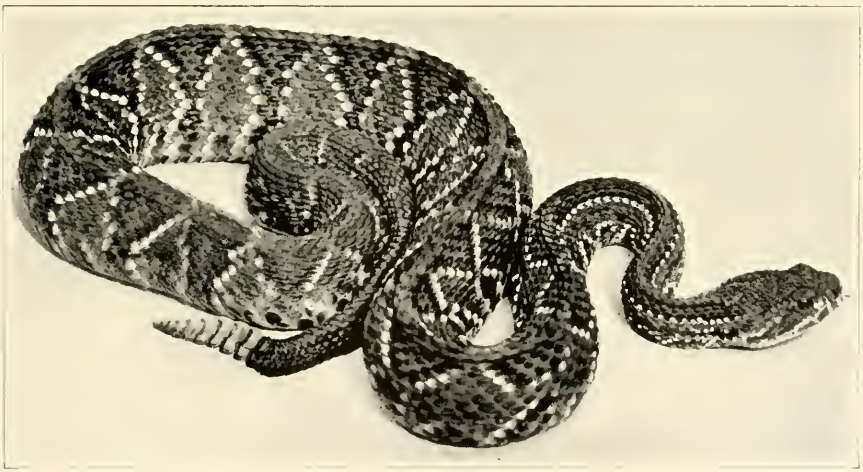

Fig. 75. *Crotalus durissus terrificus.*
South American Rattlesnake (12a).
(Specimen from Central Brazil. Photo by courtesy of the New York Zoological Society).

* This number refers to the item (not page) number in the text of the key, under which the key characters, color description, and range will be found.

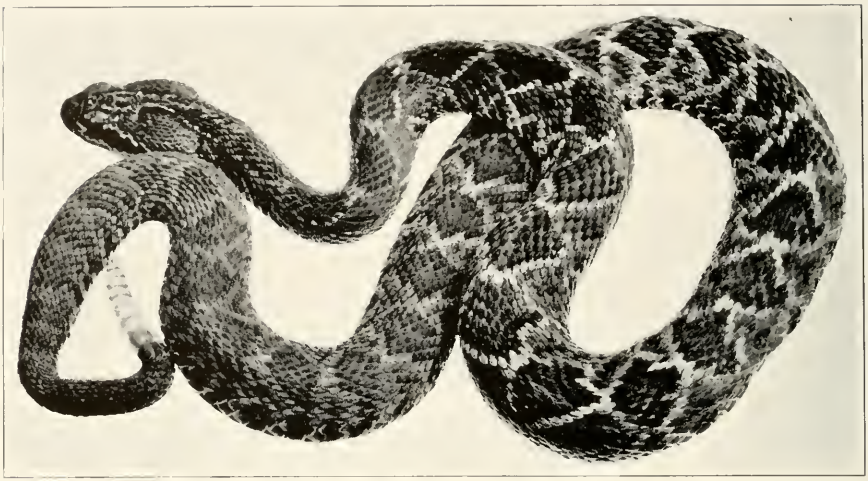

Fig. 76. *Crotalus basiliscus.*
Mexican West-Coast Rattlesnake (39b).
(Specimen from Retes, Sinaloa, Mexico).

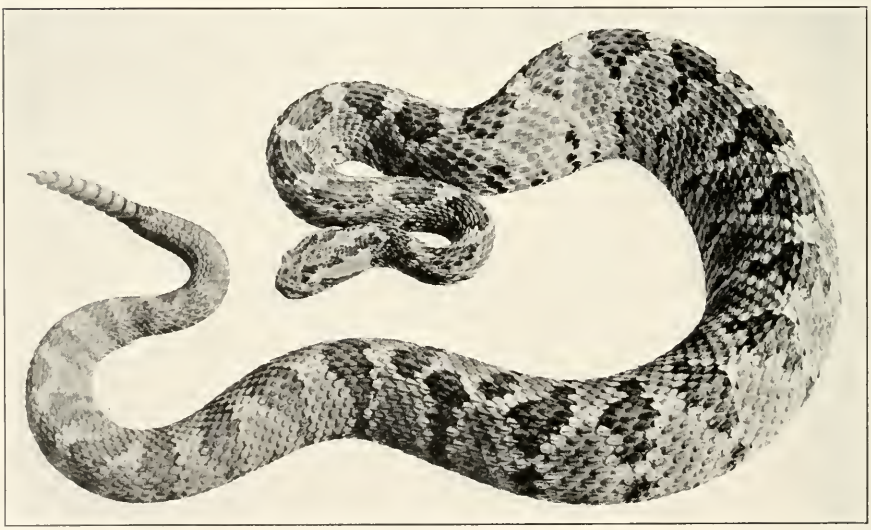

Fig. 77. *Crotalus enyo.*
Lower California Rattlesnake (31b).
(Specimen from La Rivera, Baja California, Mexico).

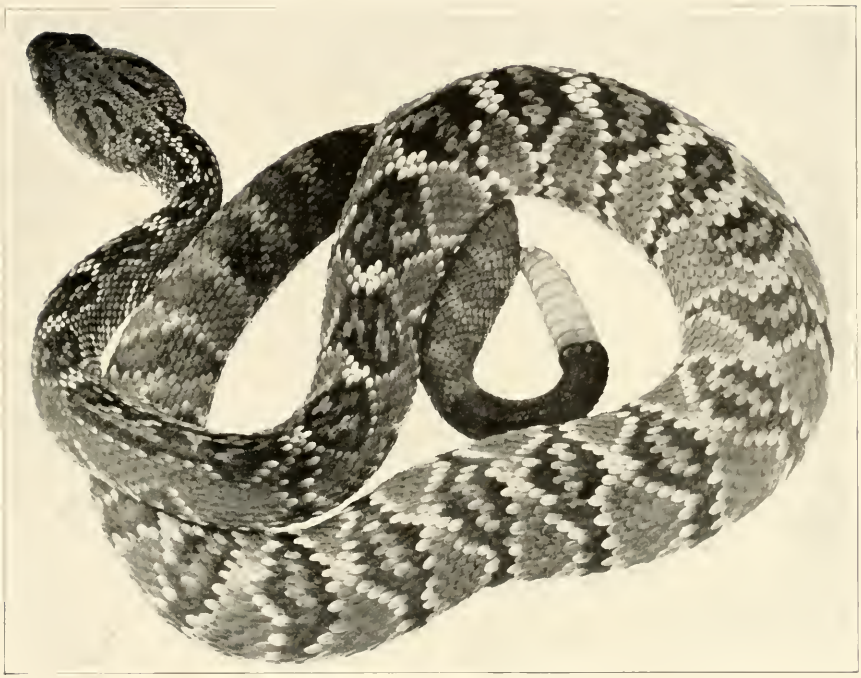

Fig. 78. *Crotalus molossus molossus.*
Northern Black-tailed Rattlesnake (40a).
(Specimen from Entro, Yavapai County, Arizona).

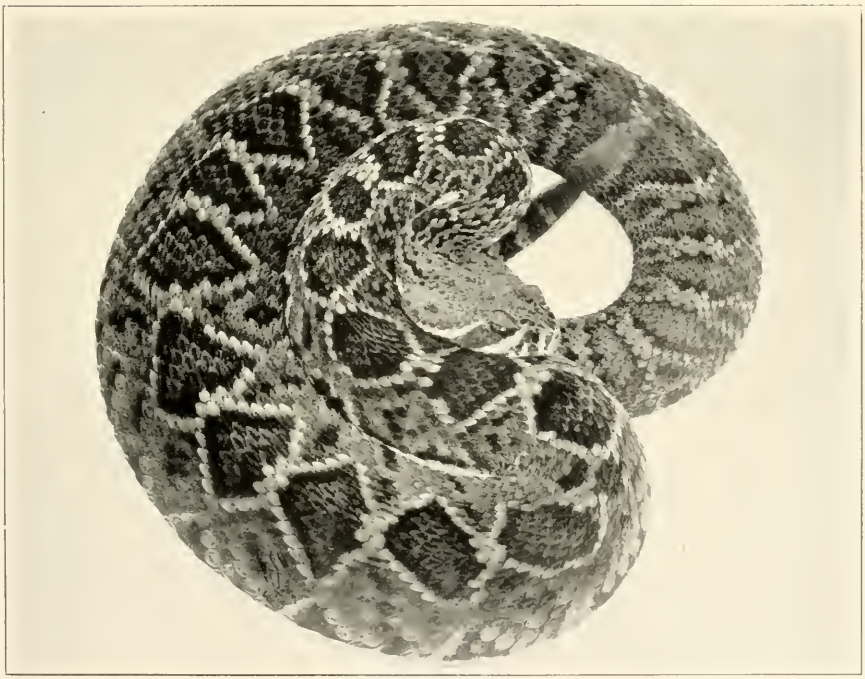

Fig. 79. *Crotalus adamanteus.*
Eastern Diamond Rattlesnake (29b).
(Specimen from Eureka, Marion County, Florida. The blur at the tail is the vibrating rattle).

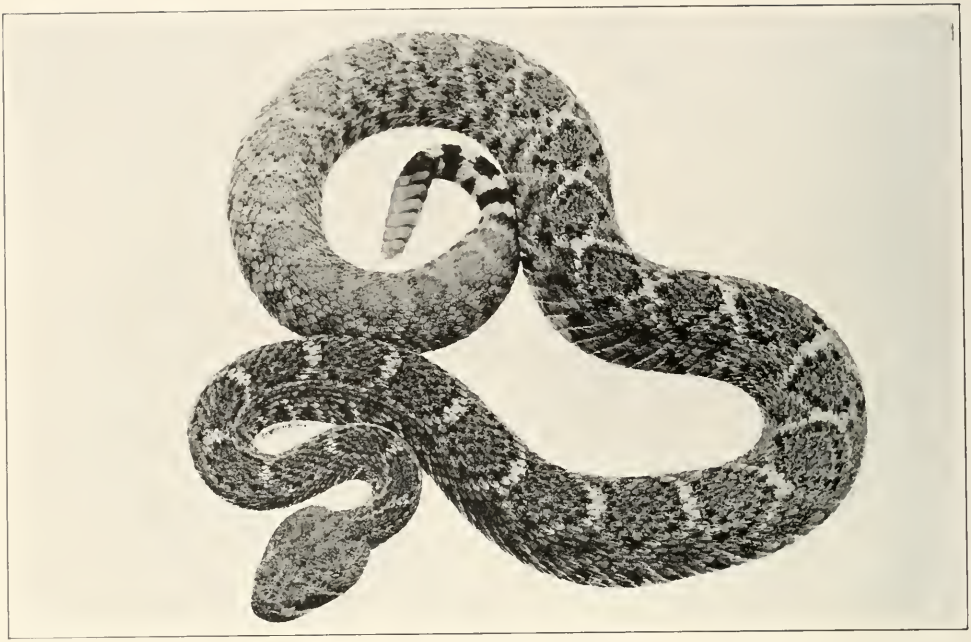

Fig. 80. *Crotalus cinereous.*
Western Diamond Rattlesnake (20b).
(Specimen from Date, Yavapai County, Arizona).

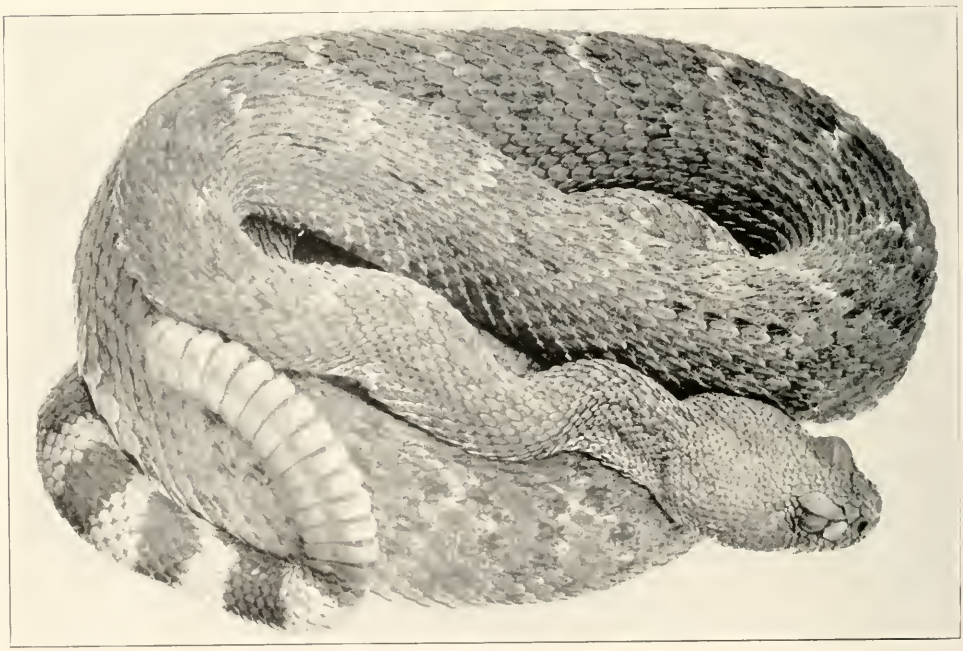

Fig. 81. *Crotalus tortugensis.*
Tortuga Island Diamond Rattlesnake (20a).
(Specimen from Tortuga Island, Gulf of California).

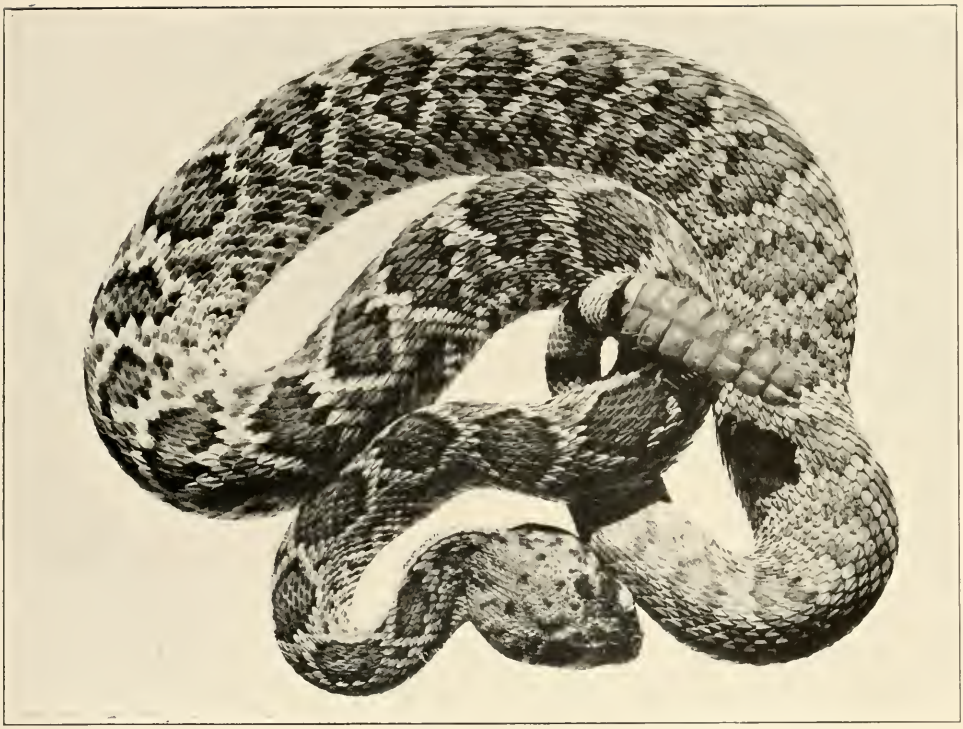

Fig. 82. *Crotalus lucasensis.*
San Lucan Diamond Rattlesnake (22b).
(Specimen from La Rivera, Baja California, Mexico).

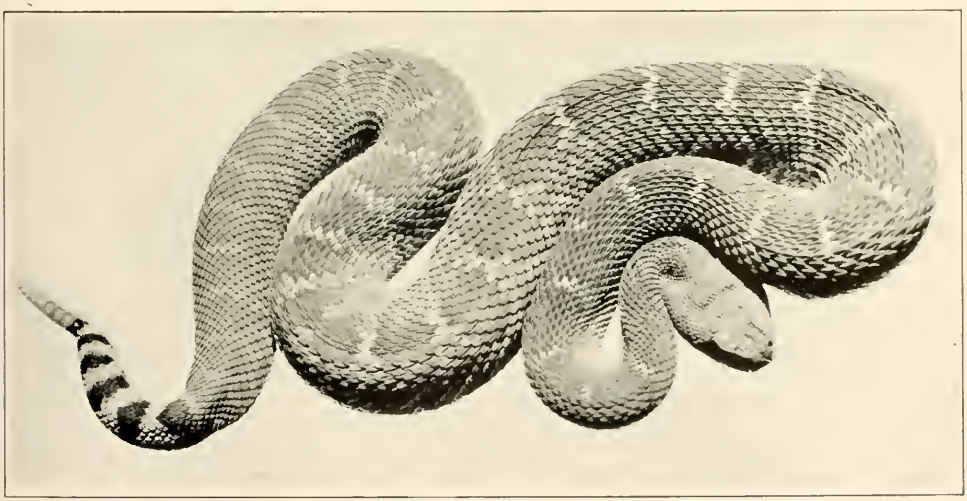

Fig. 83. *Crotalus ruber.*
Red Diamond Rattlesnake (22a).
(Specimen from Santa Margarita, San Diego County, California).

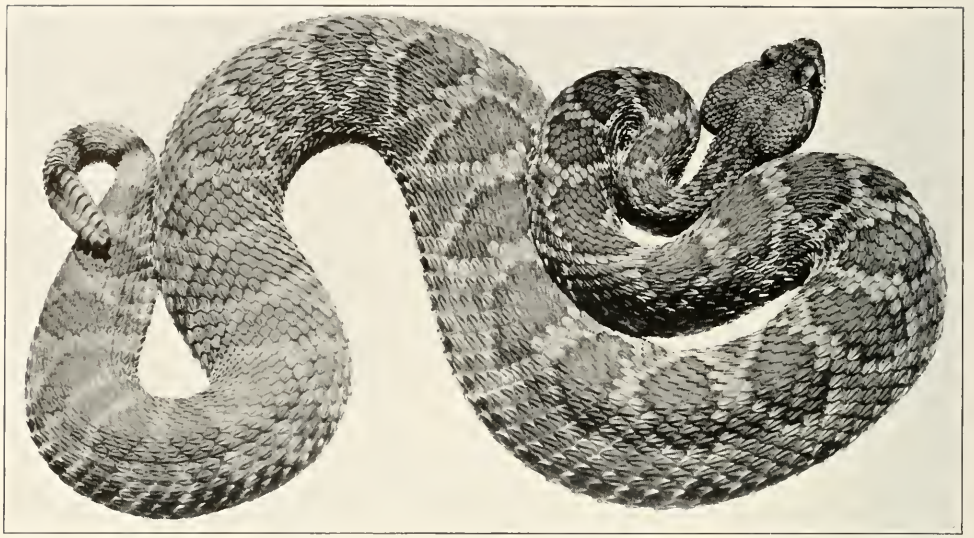

Fig. 84. *Crotalus scutulatus.*
Mohave Rattlesnake (18b).
(Specimen from Date, Yavapai County, Arizona).

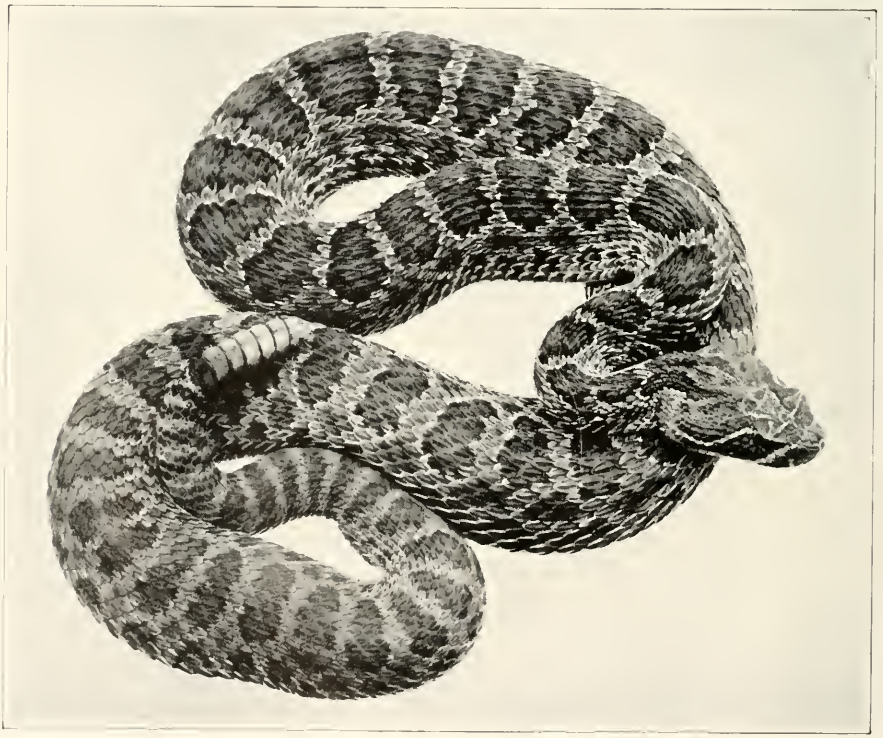

Fig. 85. *Crotalus viridis viridis.*
Prairie Rattlesnake (25a).
(Specimen from near Jetmore, Hodgeman County, Kansas).

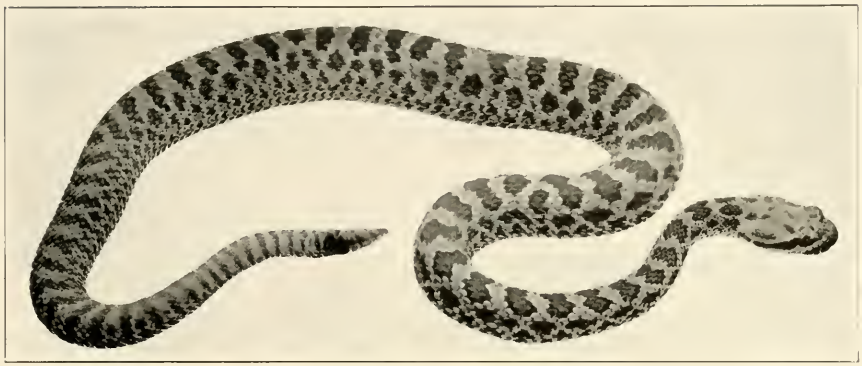

Fig. 86. *Crotalus viridis nuntius.*
Arizona Prairie Rattlesnake (25b).
(Specimen from Canyon Padre, Coconino County, Arizona).

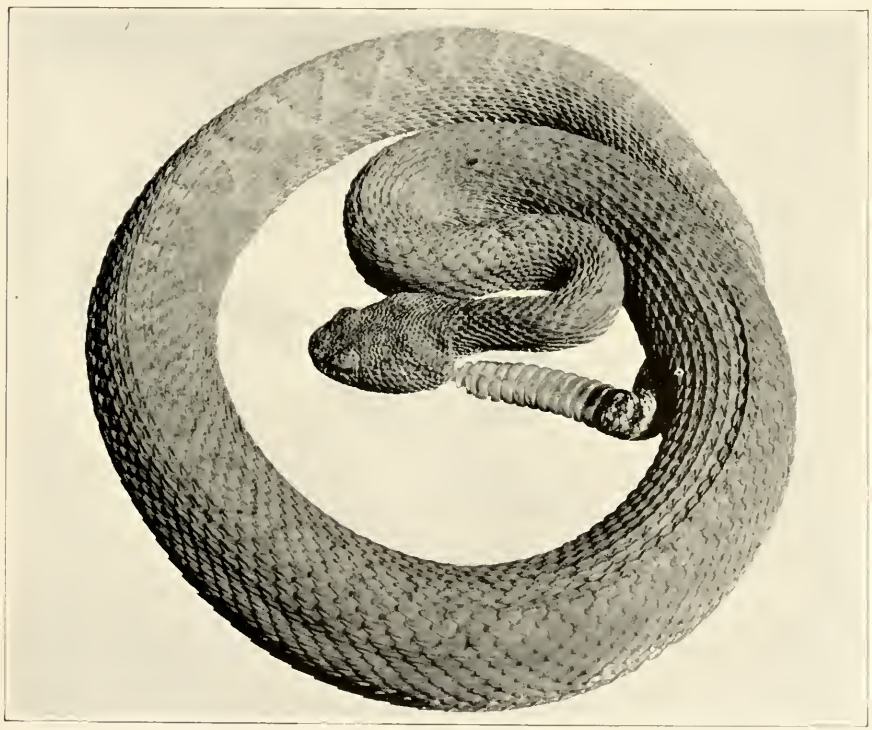

Fig. 87. *Crotalus viridis abyssus.*
Grand Canyon Rattlesnake (27b).
(Specimen from Tanner Trail in Grand Canyon, Coconino County, Arizona).

Fig. 88. *Crotalus viridis lutosus.*
Great Basin Rattlesnake (28a).
(Specimen from near Delta, Millard County, Utah).

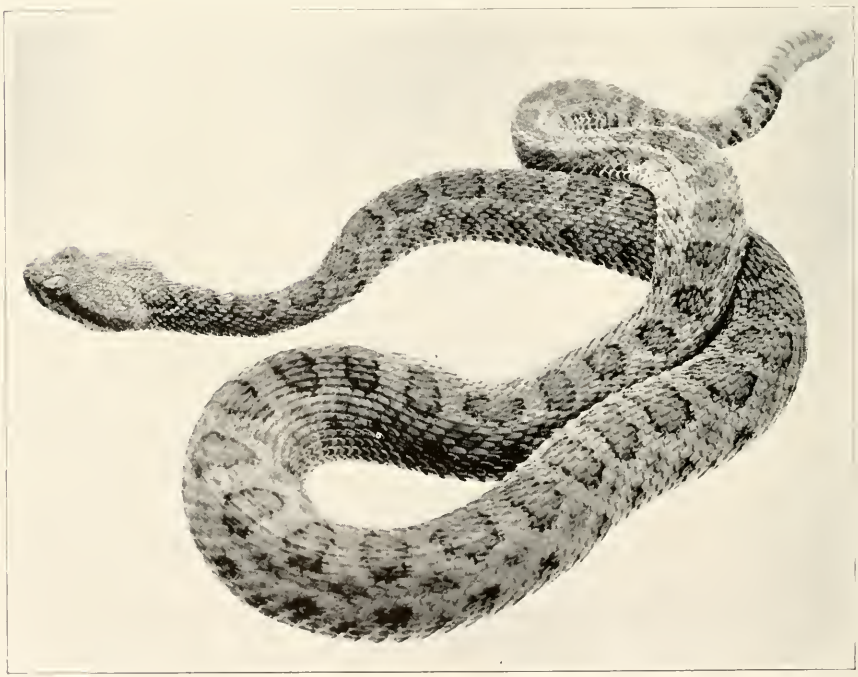

Fig. 89. *Crotalus viridis concolor.*
Midget Faded Rattlesnake (26b).
(Specimen from Jensen, Uintah County, Utah).

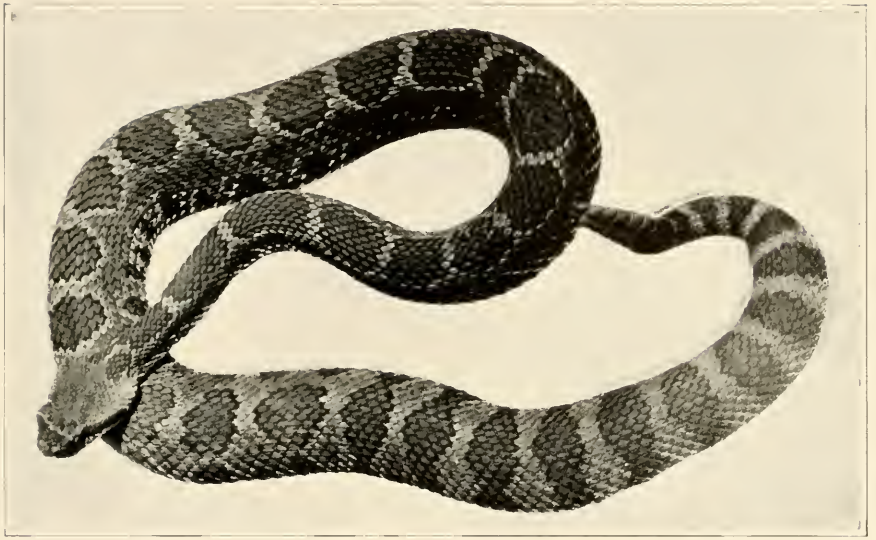

Fig. 90. *Crotalus viridis oreganus.*
Pacific Rattlesnake (28b).
(Specimen from near Wenatchee, Chelan County, Washington).

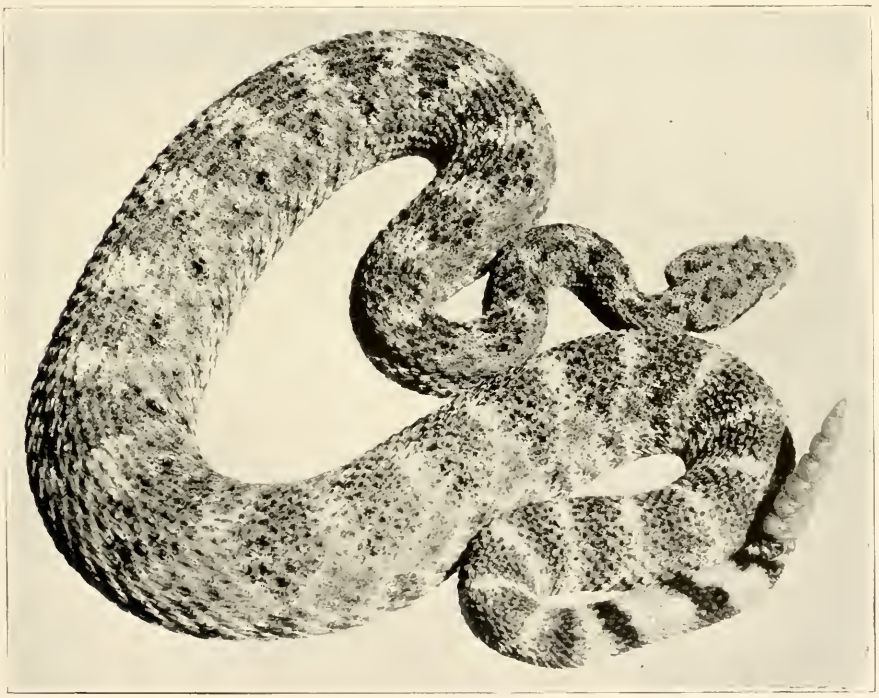

Fig. 91. *Crotalus mitchellii mitchellii.*
San Lucan Speckled Rattlesnake (16a).
(Specimen from La Rivera, Baja California, Mexico).

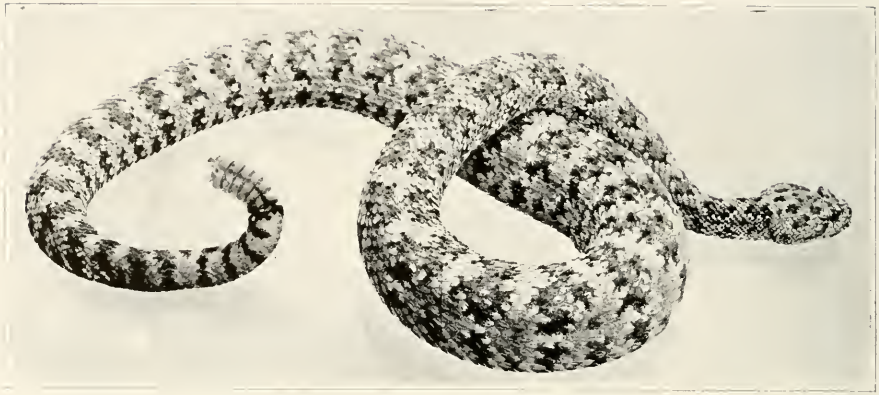

Fig. 92. *Crotalus mitchellii pyrrhus.*
Southwestern Speckled Rattlesnake (16b).
(Specimen from Yaqui Well, San Diego County, California).

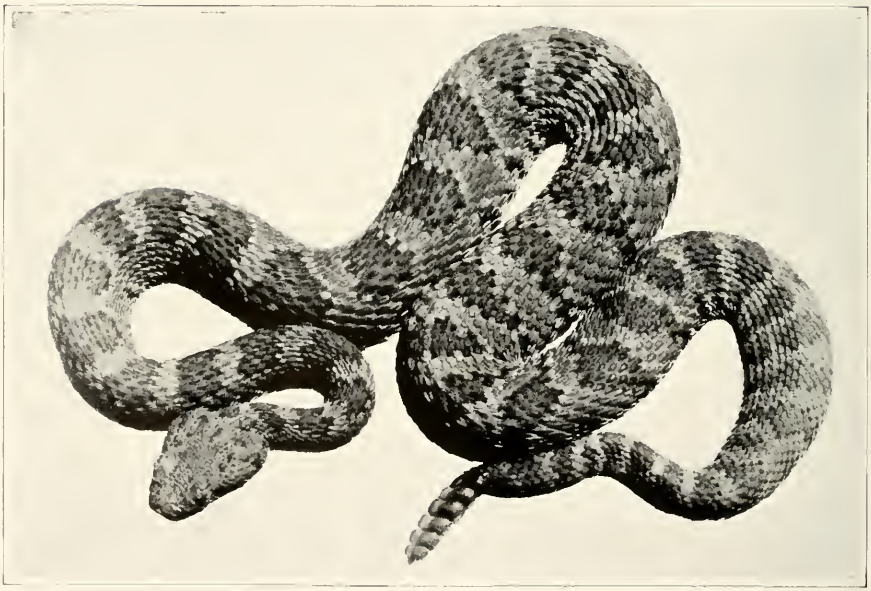

Fig. 93. *Crotalus mitchellii stephensi.*
Panamint Rattlesnake (30b).
(Specimen from near Aberdeen, Inyo County, California).

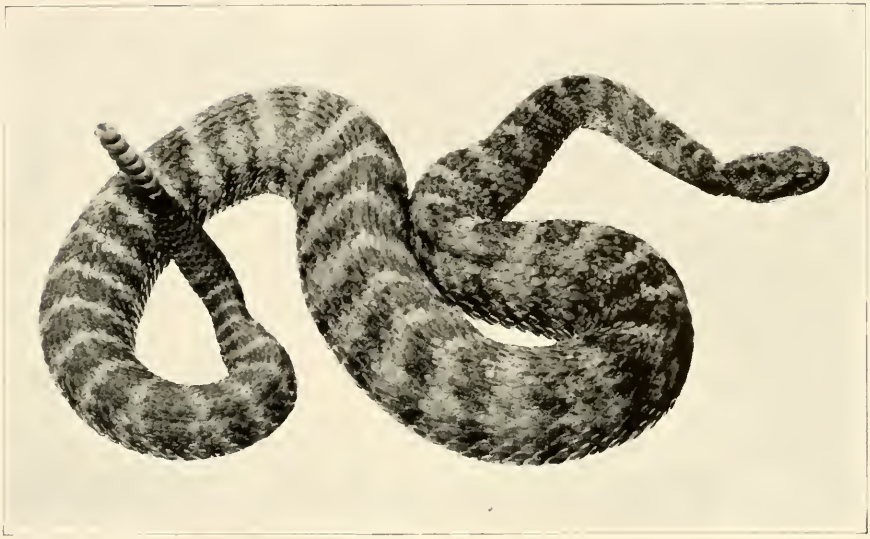

Fig. 94. *Crotalus tigris.*
Tiger Rattlesnake (33b).
(Specimen from Squaw Peak, Maricopa County, Arizona).

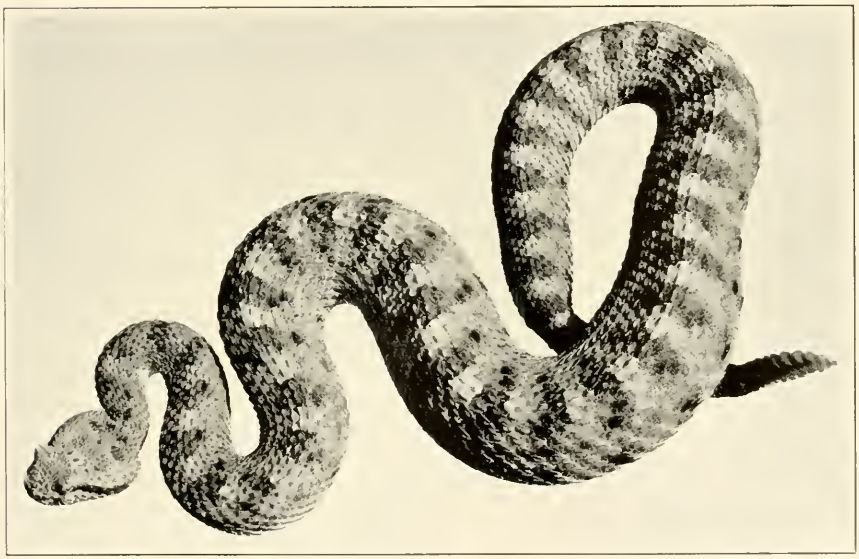

Fig. 95. *Crotalus cerastes.*
Horned Rattlesnake or Sidewinder (8b).
(Specimen from Borego Valley, San Diego County, California).

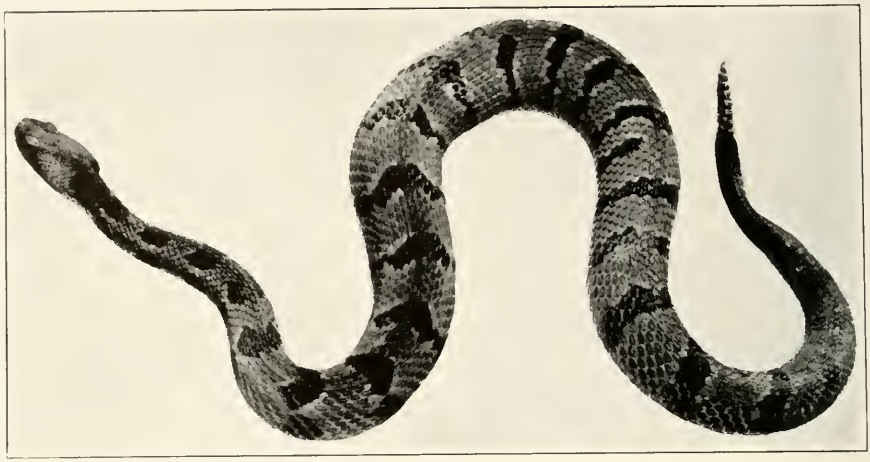

Fig. 96. *Crotalus horridus horridus.*
Timber Rattlesnake (35a).
(Specimen from near Baraboo, Sauk County, Wisconsin).

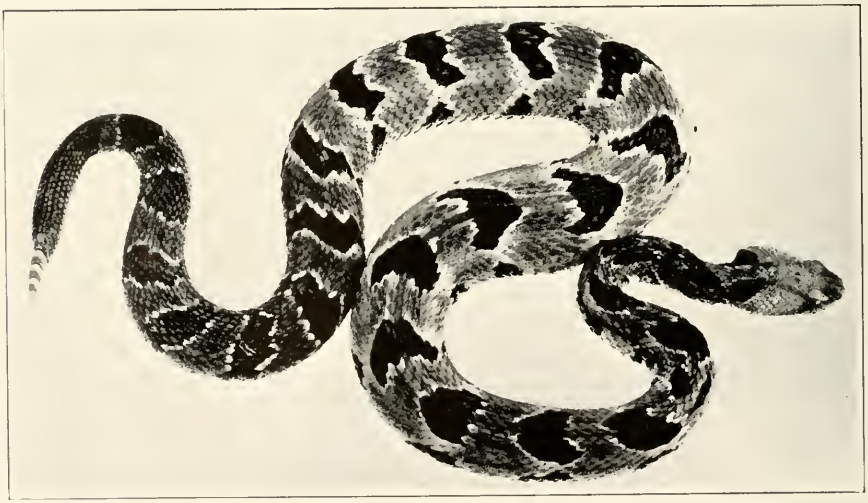

Fig. 97. *Crotalus horridus atricaudatus.*
Canebrake Rattlesnake (35b).
(Specimen from Imboden, Lawrence County, Arkansas).

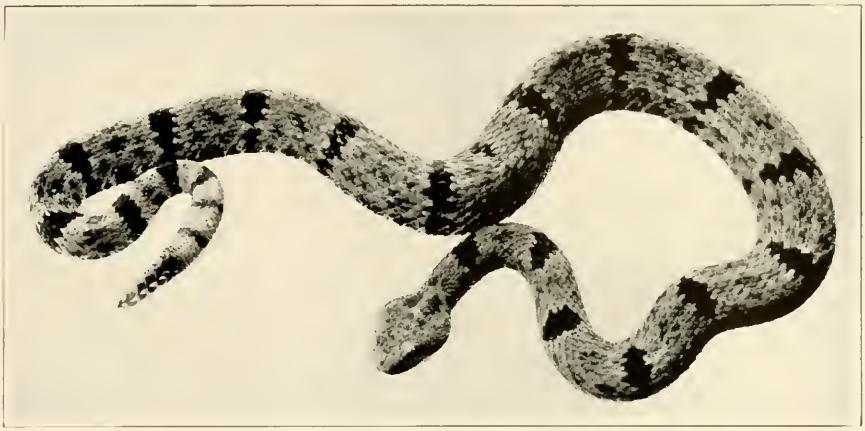

Fig. 98. *Crotalus lepidus lepidus.*
Eastern Rock Rattlesnake (14a).
(Specimen from Mt. Locke, Jeff Davis County, Texas).

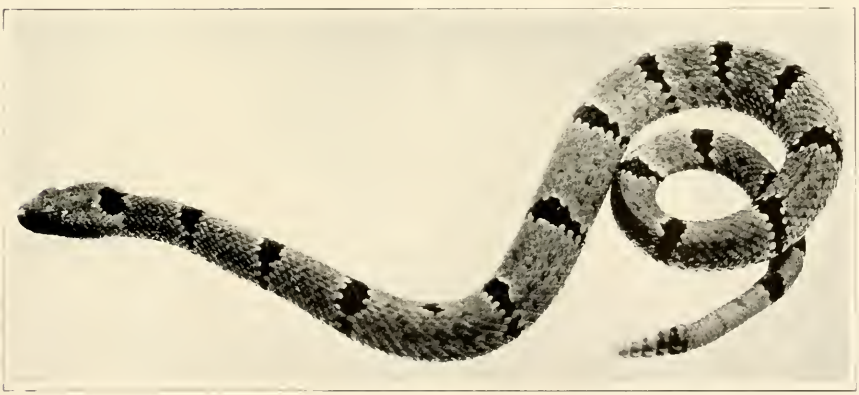

Fig. 99. *Crotalus lepidus klauberi.*
Green Rock Rattlesnake (14b).
(Specimen from Pinos Altos Mts., Grant County, New Mexico).

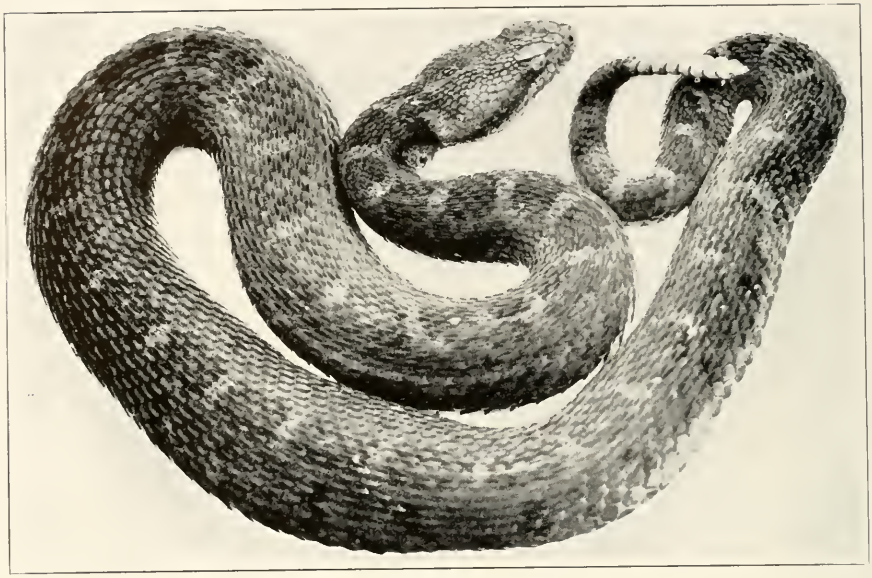

Fig. 100. *Crotalus triseriatus triseriatus.*
Mexican Spotted Rattlesnake (37a).
(Specimen from Jacala, Hidalgo, Mexico).

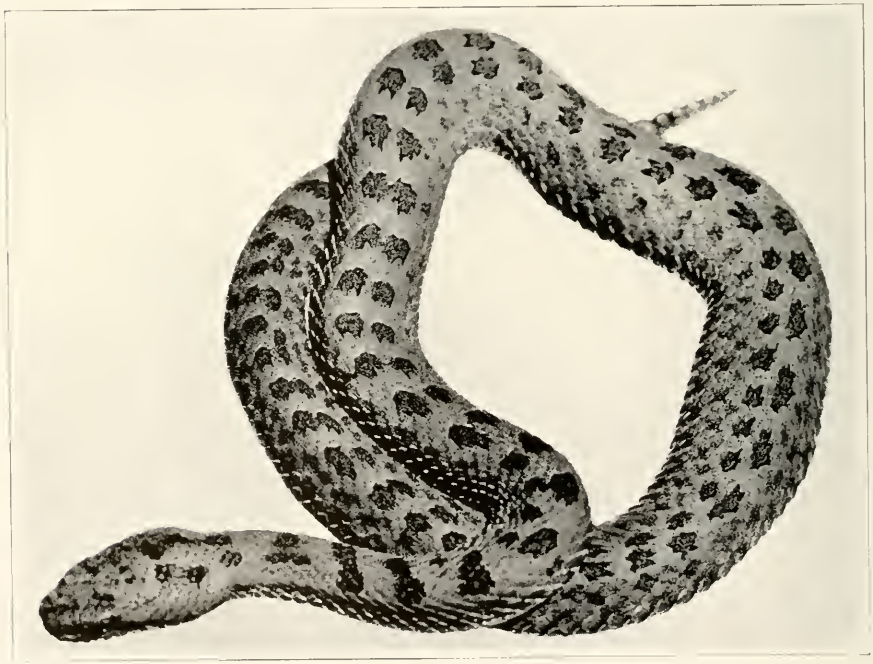

Fig. 101. *Crotalus triseriatus pricei.*
Arizona Spotted Rattlesnake (37b).
(Specimen from Ramsey Canyon, Huachuca Mts., Cochise County, Arizona).

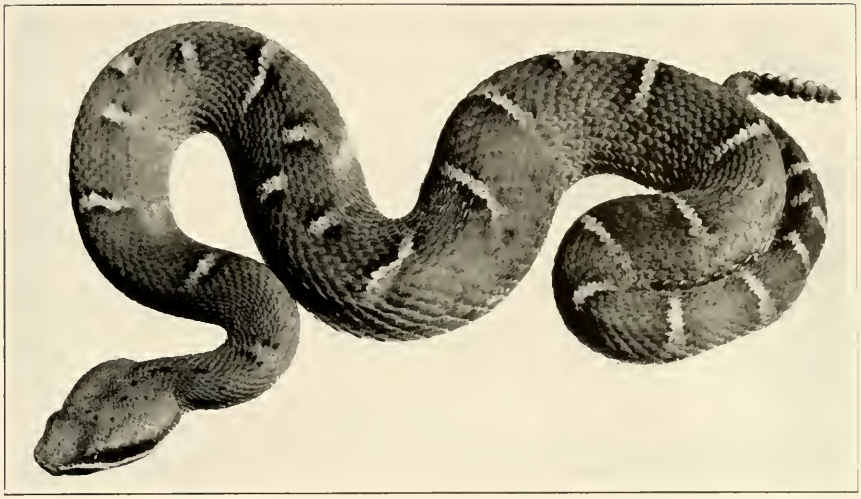

Fig. 102. *Crotalus willardi.*
Ridge-nosed Rattlesnake (9b).
(Specimen from Ramsey Canyon, Huachuca Mts., Cochise County, Arizona).

Fig. 103. *Sistrurus miliarius miliarius.*
Carolina Ground Rattlesnake (6b).
(Specimen from Leesville, South Carolina. Photo by courtesy of Howard K. Gloyd).

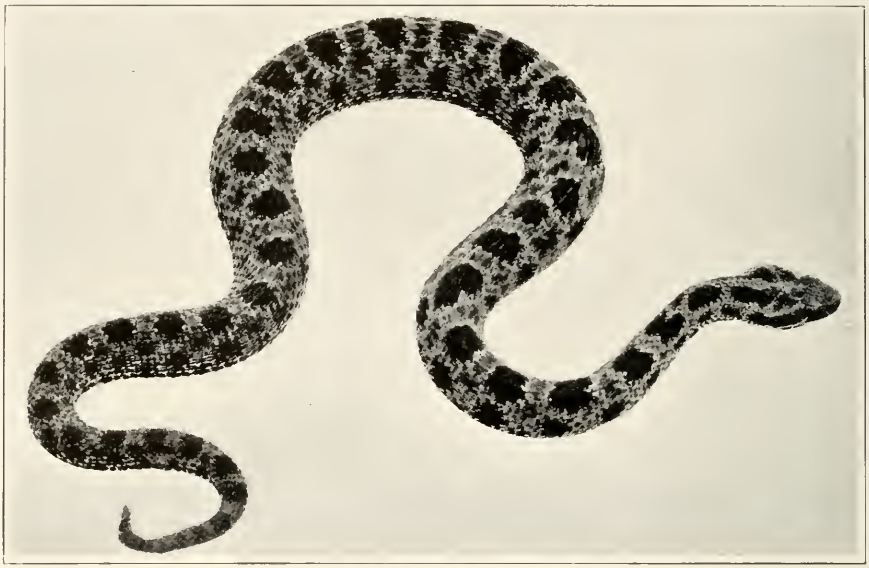

Fig. 104. *Sistrurus miliarius barbouri.*
Southeastern Ground Rattlesnake (5b).
(Specimen from Marion County, Florida).

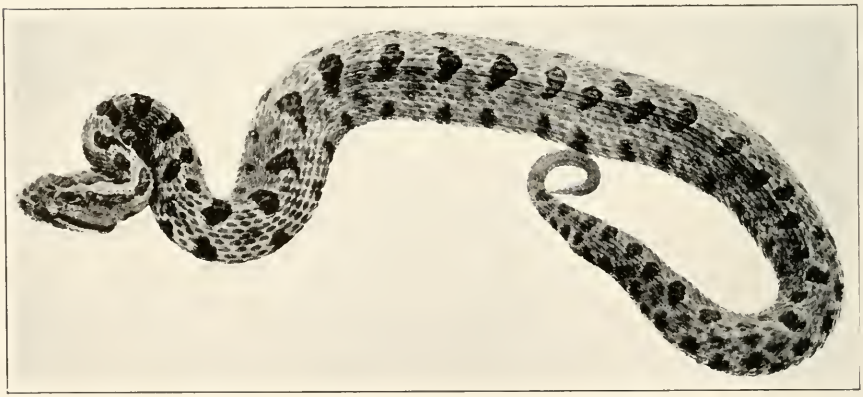

Fig. 105. *Sistrurus miliarius streckeri.*
Western Ground Rattlesnake (6a).
(Specimen from Gentilly, Orleans Parish, Louisiana).

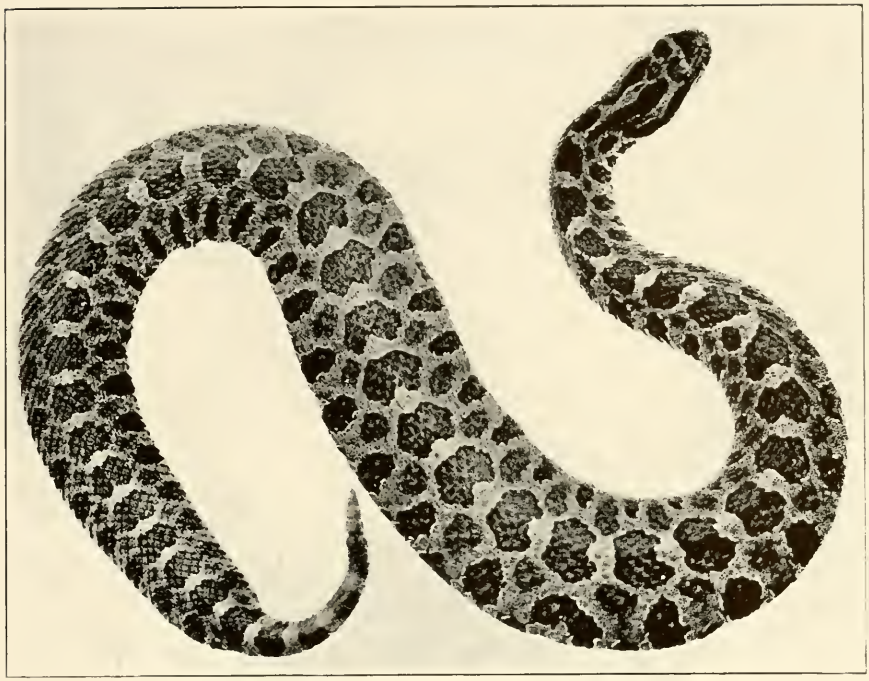

Fig. 106. *Sistrurus catenatus catenatus.*
Eastern Massasauga (4a).
(Specimen from Proud Lake, Oakland County, Michigan. The flattened posture is one often assumed by an angered rattler).

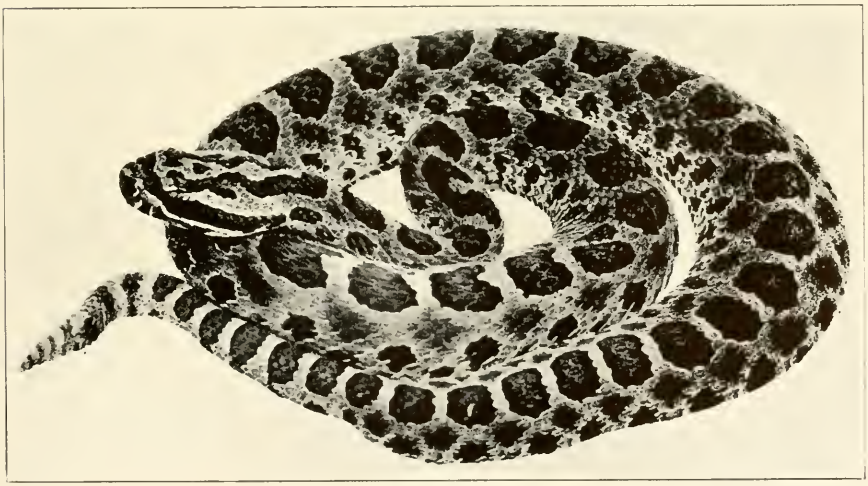

Fig. 107. *Sistrurus catenatus tergeminus.*
Western Massasauga (4b).
(Specimen from China Spring, McLennan County, Texas).

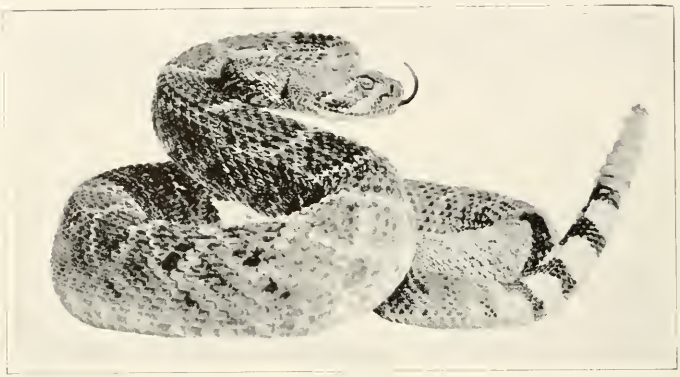

Fig. 108. A rattlesnake in a striking coil or typical defensive posture.
(*Crotalus cinereous,* Western Diamond Rattlesnake, Riverside County, California).

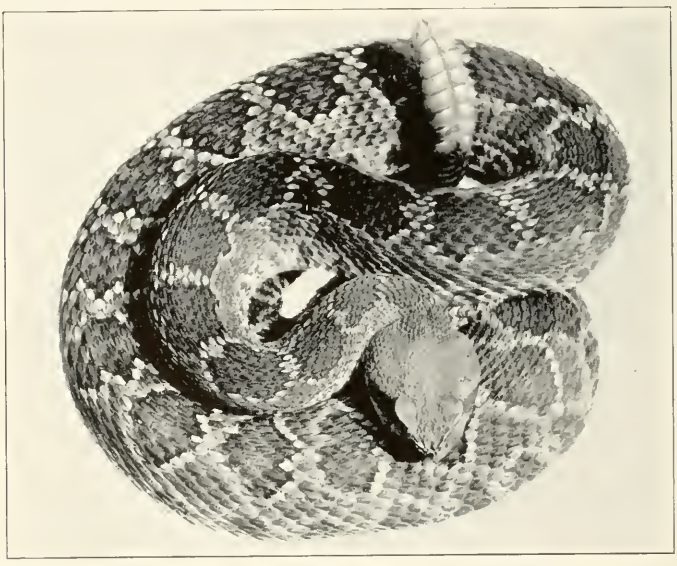

Fig. 109. A rattlesnake in its resting coil.
(*Crotalus viridis oreganus,* Pacific Rattlesnake, San Diego County, California).

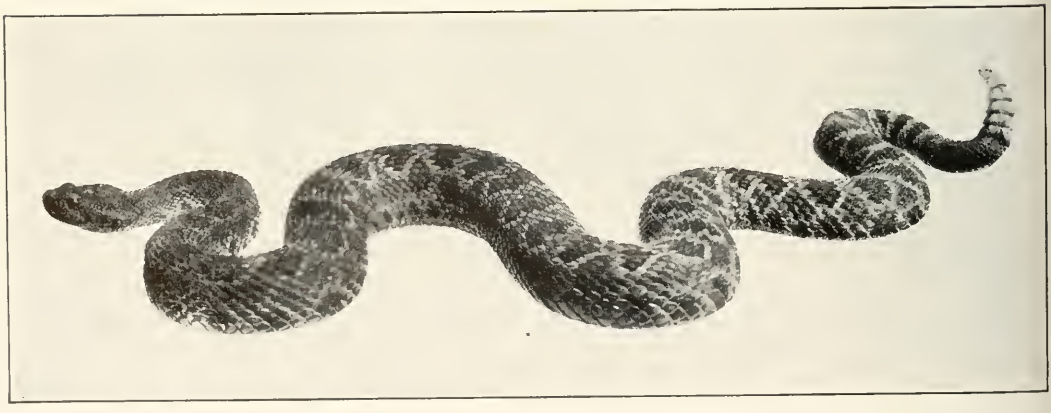

Fig. 110. A rattlesnake crawling; note how the rattle is elevated to prevent dragging.
(*Crotalus viridis oreganus,* Pacific Rattlesnake, San Diego County, California).

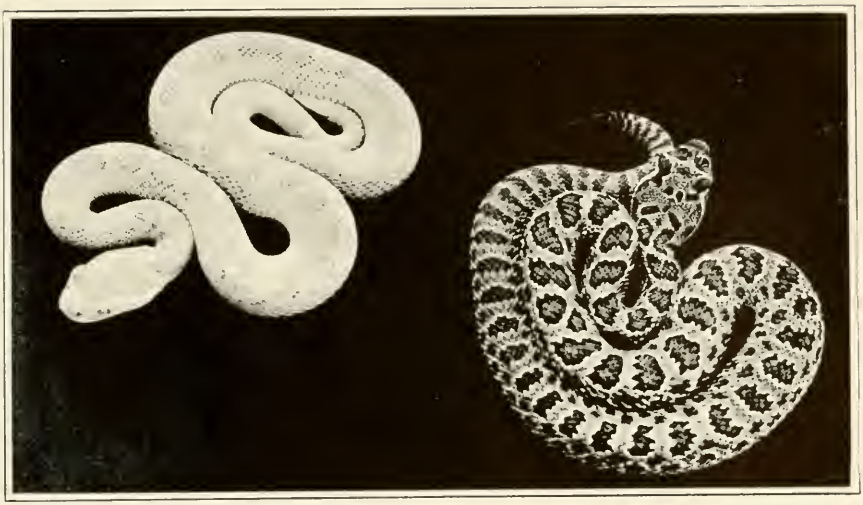

Fig. 111. A juvenile albino rattlesnake, compared with one of normal coloration. (*Crotalus viridis viridis*, Prairie Rattlesnake, Weld County, Colorado).

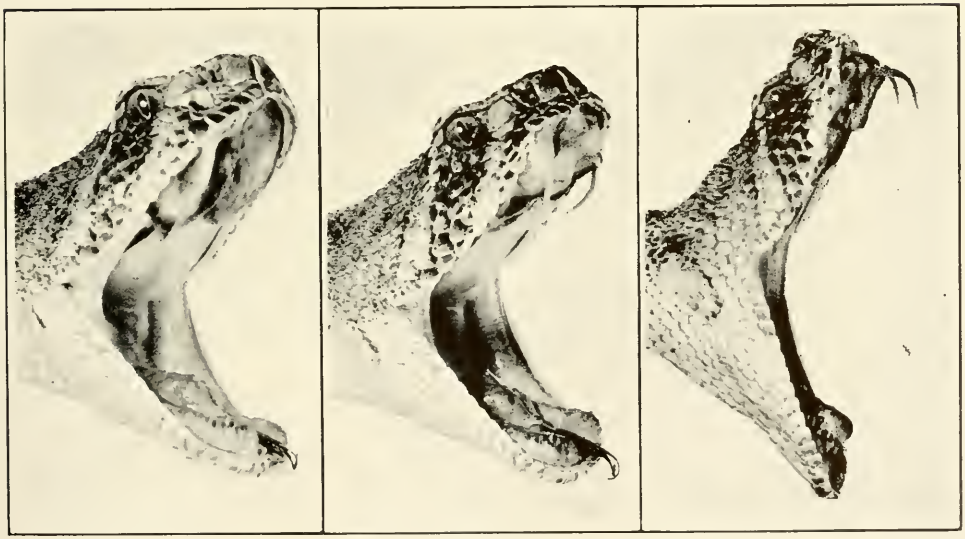

Fig. 112. The biting mechanism of the rattlesnake.

These are poses of a freshly killed specimen of *Crotalus cinereous*, with mouth opened to show the fangs. In the left-hand figure the fangs are folded against the roof of the mouth and are covered by their sheaths. In the central figure the fangs are slightly advanced and the sheaths have been cut away. The right fang has been outlined in white to bring it out. In the right-hand figure the mouth has been widely opened and the fangs advanced, as at the end of the forward drive of a strike.

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NEW PORCELLANIDS AND PINNOTHERIDS FROM TROPICAL NORTH AMERICAN WATERS

BY

STEVE A. GLASSELL

Research Associate in Crustacea, San Diego Society of Natural History

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INTRODUCTION

The littoral fauna of the west coast of Mexico, during the last few years, has produced many interesting additions to the known list of marine invertebrates. With the descriptions of these new Pacific species the foundations are being laid for a more intelligent study of the analogies which exist between faunas of the tropical Pacific and Caribbean seas. This study, revealing as it does relationships, still close, between many of our new species and those already known from Caribbean and Atlantic waters, clearly demonstrates the comparatively recent intrusion of a land barrier separating the Atlantic and Pacific oceans.

This paper, then, is an attempt to bring our knowledge of a small portion of this western fauna up to date by describing a number of newly found forms of those crab-like Anomurans, the Porcellanids. More than fifty years have passed since Lockington described a number of this group from the Gulf of California. Since that time very little attention has been paid to the Porcellanids in this area. It is hoped that, at this time, the addition of thirteen new species from those waters may make amends for this neglect.

In addition to these Porcellanids, three new species of Pinnotherids are also described: one from Panama, the other two from the Gulf of California.

I wish to express my thanks to Dr. Mary J. Rathbun and Dr. Waldo L. Schmitt of the U. S. National Museum, and to Dr. Isabella Gordon of the British Museum (Natural History), for their encouragement, valuable suggestions and assistance. I am indebted to Mr. Anker Petersen of Beverly Hills, California, for the drawings of the text figures.

PORCELLANIDAE

Petrolisthes schmitti, new species

Type.—Female, holotype, Cat. No. 71534, and male, paratype, U. S. National Museum: from San Felipe, Baja California, Mexico, low tide; June 8, 1933; collected by Steve A. Glassell. Two paratypes, female and male, Cat. Nos. 765 and 766, S. D. S. N. H.; from same series.

Diagnosis.—Carapace quadrilateral. Chelipeds short; carpus short, unarmed. First antennal peduncle lobed. A small species.

Description.—Carapace as long as wide, sides subparallel, margined with a distinct ridge; epibranchial regions roughened with rugae, remaining regions smooth, but having a few scattered tufts of tomentum. Front depressed, a single undivided process, not trilobate; line of front sinuous over antennules, slightly tomentose. Eyes large. Upper ocular margin smooth. First antennal peduncle with a horizontally depressed, distal lobe; second peduncle lightly granulate.

Chelipeds short, stout; merus short, a small lobe at distal inner angle, not protruding as far as outer edge of carpus; carpus 2/3 as long as wide, unarmed, with two shallow, longitudinal sulci dividing the surface into three granulated ridges; hands short, thick, subequal, similar, a longitudinal median swelling from proximal end to gape, bordered by indistinct sulci; outer part of hand and fingers granulate, with a light film of tomentum near margins; palms of hands smooth, with tufts of sponge-like hair in the gape of the fingers; pollices blunt at tips, upturned; dactyli long, sinuous, granulate, with prehensile edges closely meshing pollices.

Ambulatory legs longer than body length, decorated with irregular tufts of tomentum, sparingly setose.

Abdomen and epimera fringed with tomentum.

Color in alcohol.—A red-brown mottled with white.

Measurements.—Female holotype: length of carapace 4.7 mm., width 4.7 mm. Male paratype: length 4.4 mm., width 4.1 mm.

Range.—Upper part of the Gulf of California.

Material examined.—San Felipe, Baja California, June 8, 1933; 4 males and 7 females; collected by the author. The types for this species were selected from this series.

Habitat.—Taken at low water from under rocks.

Remarks.—This proposed species is allied to *P. gracilis,* Stimpson, 1859, in which the shape of the front is similar, but it differs from that species in that *P. schmitti* has short heavy chelipeds, with longitudinal sulci and granulated ridges on the carpus, while in *P. gracilis* the chelipeds are long, and the carpus is long, smooth and narrow. *P. schmitti* has tufts and fringes of tomentum, while *P. gracilis* is nude.

This species, being of such small size, might be considered to be in the adolescent stage, if it were not for the fact that most of the females were gravid, and that intensive collecting failed to produce larger specimens.

This species is dedicated to Dr. Waldo L. Schmitt, of the U. S. National Museum, with feelings of warm personal regard and admiration.

Petrolisthes sanfelipensis, new species

Type.—Male, holotype, Cat. No. 71535, and female, paratype, U. S. National Museum: from San Felipe, Baja California, Mexico, low tide; June 8, 1933; collected by Steve A. Glassell. Two paratypes, male and female, Cat. Nos. 767 and 768, S. D. S. N. H.; from same series.

Diagnosis.—Carapace striated, bearing spines on the front, ocular margin, and on the hepatic, branchial and protogastric regions. Nearly the entire dorsal and ventral surfaces covered with either striations or squamae.

Description.—Carapace nearly as long as wide, regions well marked, transversely plicated with micro-piliferous striae, interrupted by the cervical groove and cardiac margins; a row of spines completely across the carapace behind the eyes, interrupted by the median sinus and cervical groove; a group of spines on the epibranchial region and a spine on the margin posterior to the hepatic region. The front is triangular, depressed, and margined with thick-set blunt teeth, separated from the ocular margin by a sinus. The supraocular margin is armed with sharp, forward-pointing teeth, increasing in length anteriorly; a single sharp, postorbital tooth. Other teeth may be present on the forward part of the carapace in some specimens, but, for the most part, those described here are not subject to change in location. The eyes are large, the distal end of the stalk being fringed with red hair. The distal end of the first antennal peduncle bears a horizontally compressed plate, armed with teeth on its outer margin; the second peduncle is roughened on its outer surface with blunt tubercles; the third is plain.

The chelipeds are long and narrow; merus armed at its distal inner angle with a long rugose lobe surmounted with a sharp spine, its distal margins armed with spines, its surface transversely crossed with interrupted striae; the carpus is nearly twice as long as wide, armed on its inner margin with four or five major multiformed teeth; these teeth are covered on their long proximal edges with smaller denticles, the distal margins being short and tuberculate; the carpus may be divided into three longitudinal parts; the outer part is armed with a series of 7 or 8 forward- and upward-pointing spines, which are inside the margin and are connected with transverse striae which come up from the under side of the carpus; these spines border an interrupted sulcus; the median portion of the carpus is raised and formed of transverse laminae broken up, and this is separated from the inner side by another interrupted sulcus; the remaining portion is covered with piliferous, sharp-pointed, granulated rugae; the distal end has several teeth; the manus is long and slender, and oblique plications from the inner palm come over the crest to an inner-marginal sinus; the median ridge is

formed of longitudinally oblique, granulate-edged plications which connect with the marginal sinus; from this ridge to the outer margin the surface is covered with lamellar rugae, the interspaces filled with a short tomentum; the outer border is tomentose proximally and armed with a series of sharp, short spines; the pollex is long, thin and upturned at the tip; the dactyli fit closely to the pollices, and they are armed on their upper inner crest with a row of upward- and forward-pointing, sharp spines; their tips are compressed and multiunguiculate; on the inner side the fingers are covered with a sponge-like tomentum, short cropped; the inner side of the hand and fingers is lined with oblique, granulated striations. The under side of the carpus, merus and propodus is transversely striate.

The ambulatory legs are rather long, the merus in all three being transversely striate, and the upper crests armed with three or four sharp, outward-pointed teeth; the distal posterior end of the merus of the first and second legs has spines, as has also the upper distal end of the carpus on these legs; the propodus is nearly 1½ times as long as the dactylus; the dactyls are curved, with a corneous tip, armed on their under sides with four corneous spines.

The abdomen is transversely striated on all segments, bordered with setae.

The first three segments of the outer maxillipeds are striated.

Color in life.—A faint pinkish tint, but when freshly preserved in alcohol is beautifully colored with rich reds and purple.

Measurements.—Male holotype: length of carapace 8.7 mm., width 9 mm. Female paratype: length 7.6 mm., width 7.9 mm.

Range.—Upper end of the Gulf of California.

Material examined.—A series of 10 males and 10 females, collected at San Felipe, Baja California, June 8, 1933, by the author; the types were selected from this series. A series of 10 males and 10 females, collected at Punta Peñasco (Rocky Point), Sonora, May 2, 1935, by the author.

Habitat.—Taken at mean low tide level and below, from among sponges and gorgonians.

Remarks.—This proposed species is allied to *P. hirtispinosus* Lockington, 1878, but differs from that species in the greater number of spines on the carapace and front, the more distinctive markings of the carapace, the less equal distribution of spines on the carpus of the chelipeds, and in the hand not being covered with a short pile of tomentum. Also, the ventral part of *P. hirtispinosus* is not striated.

Petrolisthes nigrunguiculatus, new species

Type.—Male, holotype, Cat. No. 71536, and female, paratype, U. S. National Museum: from Santa Catalina Island, Gulf of California, Mexico, low tide; December 14, 1931; collected by Steve A. Glassell. Two paratypes, male and female, Cat. Nos. 769 and 770, S. D. S. N. H.; from same series.

Diagnosis.—Carapace flattened, smooth in central regions, squamoso-granulate on front and anterior margins, front deflexed. Chelipeds of male dissimilar, tuberculate.

Description.—Carapace about equally wide as long, depressed, central regions smooth, anterior margins and front squamoso-granulate and microscopically covered with tomentum; a transverse hepatic lobe; a well-defined protogastric ridge; front deflexed, triangular, with a wide ridge-bordered median sulcus; the upper ocular margin paralleled by a groove which terminates in a notch, this notch separates the front from the preorbital lobes. First antennal peduncle with a prominent lobe distally; second peduncle serrated with granules on outer surface; third smooth; flagellum smooth.

Chelipeds of males, dissimilar; of females, similar in some, in others as in the males; merus with inferior distal end extending nearly 1/3 the distance to the hooked tip of the carpus; the inner distal end has a long subvertical, blunt, granulated lobe; carpus short, about twice as long as wide, covered with squamoso-granules along the median ridge, with irregular tuberculate granules on the remaining surfaces, the inner margin armed with three or more clustered, blunt-ended teeth, the distal posterior end a long, forward-curving tooth; hands covered with various sized squamous granules and tubercles, the inner margin rounded, the outer sharp and fringed with an even length of fine pinnate hair, growing out of flat, lamellar serrations to a point near the blunt tip of the pollices; also extending over the fringe is a series of short, subequally spaced, transverse ridges, ending as teeth; the major hand of the male has a median swollen ridge to the gape; the pollex is thick, stubby; the dactylus stubby, distorted, extending past the pollex and bluntly curved at the tip; these fingers gape widely and cannot be brought together, due to a large, distorted lobe on the proximal cutting edge of the dactylus; the inner surface of the dactylus has a heavy growth of pinnate hair, which is absent or present in less quantity on the minor chela; in the females with similar hands this growth may be entirely absent. The minor chela of the males is similar to both chelas in the majority of females, in which the tip of the pollex is truncate, thin and wide, the dactyl long, curving, and engaging the pollex for its entire length; the surface is as that of the major chela.

The ambulatory legs are short; merus compressed, wide, crested with minute granules distally; carpus and propodus longitudinally ridged with rows of small teeth, lightly fringed with setae; dactyli with curved corneous tips; a distinctive feature of these dactyli is their color—a deep, dark brown, almost black.

Color in life.—Thickly mottled with dark brown and reds. Tips of chela a light red. Tomentum and fringes a dirty white.

Measurements.—Male holotype: length af carapace 7.2 mm., width 7 mm. Female paratype: length 7.5 mm., width 7.3 mm.

Range.—Gulf of California.

Material examined.—Approximately 20 males and 20 females, Santa Catalina Island, Gulf of California, December 14, 1931, collected by the author. The type material was selected from this series.

Habitat.—Under side of rocks at low and half tide levels.

Remarks.—This proposed species is closely allied to *P. hirtipes* Lockington, 1878, which is found in the same region, but the latter may be distinguished from *P. nigrunguiculatus* by some of the following characters: *P. nigrunguiculatus* is smooth in the central regions of the carapace, instead of rugose; the carpus of the chelipeds is armed with several lobular spines, instead of having but one lobular group at the proximal end; the front is unbordered with setae, instead of being fringed with fine thick hair; only the outer margins of the hands are fringed, instead of the entire margins of the chelipeds and ambulatory legs. *P. hirtipes* is also the larger species of the two, a male collected at Magdalena Bay, Baja California, December 4, 1931, measured: length of carapace 10 mm., width 10 mm.

Petrolisthes tiburonensis, new species

Type.—Female, holotype, Cat. No. 71537, and male, paratype, U. S. National Museum: from south end of Tiburón Island, Gulf of California, Mexico, low tide; December 31, 1931; collected by Steve A. Glassell. Two paratypes, female and male, Cat. Nos. 771 and 772, S. D. S. N. H.; from same series.

Diagnosis.—Carapace convex anteriorly, very rugose; front trinoduled. Antennal peduncles nodulous. Merus of ambulatory legs carinate. Dimorphic.

Description of female.—Carapace a little wider than long, convex anteriorly, with regions well defined, anteriorly covered with lobate granules, posteriorly with well defined, disconnected striae; borders rounded over, high, except for posterior margin which is bimarginal and concave. The front is trinodulous, the nodules blunt and upturned, the median the largest and more extended. Eyes large. First antennal peduncle with a large single or bilobed process extending past the joint of the second peduncle; the latter also has two or three prominent, blunt lobes posteriorly, one distal, also many small granules; the third peduncle has a single distal lobe.

The chelipeds are similar; merus with a single upward-pointed lobe at the distal anterior margin, the surface is rugose; the carpus has subparallel margins, is rugose, with a median ridge, armed with a forward-pointed, hook-like tooth at the posterior distal end; the anterior border is armed with a series of unequal, small teeth, more numerous at the proximal end; hands similar, rounded on the inner margin, compressed on the outer, which is armed with a series of sharp, forward-pointing teeth, their anterior base setose; viewed from underneath the teeth are unequally spaced and of irregular length; on the outer surface the hands are granulate, with a wide rounded median ridge to the gape of the fingers, thence continues around the cutting edge of the pollex, and terminates at the base of the upturned tip; the prehensile fingers are distorted, with a striated upper carina, a median striated or granulated ridge, channeled on each side; the palms of the hands are smooth, the inner gape with a bunch of fine, long, pinnate hair.

The ambulatory legs are short; merus stout, armed on the upper surface with irregular, blunt, conical lobes, a median ridge with sulci on each side; the carpus of the first leg is bilobed on its upper surface, a lobe at each end, a large double-ended lobe on the distal inner side; carpi of second and third legs bilobed, eroded; propodi with longitudinal ridges; dactyli with curved corneous tips, armed underneath with short, supplemental, corneous spines; legs sparsely margined with small tufts of setae, and granulate.

Description of male.—Differs from the female in being much larger, and having the carapace, front, antennal peduncles and chelipeds much smoother. The margins of the carpus of the chelipeds are not parallel, being widest at the distal end, unarmed on the inner margin, or at best vaguely indicated. The hands are unarmed on the outer margin with either teeth or setae, being smooth and rounded. The ambulatory legs differ from those of the female in that the merus of the first leg has a smooth crest; the other legs differ only in that they are less heavily margined with lobes.

Color in life.—A chocolate brown.

Measurements.—Female holotype: length of carapace 9.2 mm., width 10 mm.; length of carpus 7.3 mm., width 2.6 mm.; length of hand 12 mm.; width at base of finger 5.8 mm. Male paratype: length of carapace 10.5 mm., width 10.8 mm.; length of carpus 12 mm., width 3.8 mm.; length of hand 21 mm.; width at base of finger 8.1 mm.

Range.—It seems peculiar that this species has so far been taken in the Gulf of California only between latitudes 28° 30′ N., and 30° N., although extensive collecting has been done on each side of these boundaries.

Material examined.—South end of Tiburón Island, Gulf of California, December 31, 1931: approximately 20 males and 20 females, collected by the author. The types have been selected from this series. Also from Angeles Bay, Baja California, January 4, 1932: 1 male and 3 females. Puerto Refugio, Angel de la Guardia Island, Gulf of California, January 6, 1932: 2 males.

Habitat.—Collected under rocks at low tide. Plentiful.

Remarks.—This proposed species is allied to *P. crenulatus* Lockington, 1878, which it somewhat resembles in the shape of the carapace and ratio of measurements (both species being wider than long). They differ in nearly every other respect, *P. tiburonensis* being brown instead of red and white, slightly setose instead of quite tomentose, etc. The chelipeds of the adult males somewhat resemble those of *P. gracilis* Stimpson, 1859, but here the resemblance ceases.

Stimpson in his description of the genus *Petrolisthes*[1] states: "Carapax depressed subovate, not broader than long." Strictly followed, neither *P. crenulatus* nor *P. tiburonensis* would be placed in the genus *Petrolisthes*, although they both agree in other particulars, for both of these species are subquadrate,

[1] Rept. on Crust. Coll. by N. Pac. Expl. Exped. 1853-56. Smithsonian Misc. Coll., Part vol. XLIX, 1907, p. 181.

instead of subovate, and are broader than long. A normal, large specimen of *P. crenulatus*, which I collected at the type locality, has the following measurements: length of carapace 13.5 mm.; width 15 mm.

Without attempting to amend the genus or create a subgenus for the reception of this and other species, I have placed it in the genus *Petrolisthes*, awaiting a much-needed, thorough revision of the Porcellanids.

I selected the female for the holotype of this species, as most of the juvenile males bear a closer resemblance to the female form than they do to the mature males.

Pisosoma smithi, new species

Type.—Female, holotype, Cat. No. 71538, and female, paratype, U. S. National Museum: from Miramar Beach, near Guaymas, Sonora, Mexico, low tide; December 23, 1931; collected by Steve A. Glassell. Female paratype, Cat. No. 773, S. D. S. N. H.; from same series.

Diagnosis.—Carapace suboval, lightly marked with transverse plications. Carpus of chelipeds nearly flat on upper surface, unarmed and rugose; hands with three ridges between the margins.

Description.—Carapace suboval, convex toward the front, nearly as long as wide, regions defined, cervical groove fairly deep near margins, the posterior 2/3 crossed with light transverse plications and punctae, more prominent near the sides and posteriorly. The front sinuous and entire in dorsal view, more prominent in front of median depression. Eyes small.

Chelipeds short, stout; merus short on dorsal side, extending further ventrally, a granulated raised carina on both upper margins, the distal inner end not protruding as far as the inner margin of the carpus; carpus rather flat on top, with both inner and outer margins projecting outward from beneath; margins unarmed, but serrated with granules, a granulated median ridge, separated from the outer margin by a granulated sinus, distally crossed by granulated, transverse striations, distal end granulate, ventral side striate; hands subequal, granulate, with three longitudinal, granulated ridges, the upper short, the lower longer, but not extending onto the pollex, which is slightly upturned at the tip; dactyli long, sinuous, granulate, with a median ridge, tip hooked; the fingers gape evenly from base to tip; under side of hand punctate, granulate in gape.

Ambulatory legs granulate on upper crest; dactyli slightly curved, tip corneous, supplemental spines on lower margin.

Color in alcohol.—Carapace cream color. Ambulatory legs a light pink. Abdomen and sternum iridescent.

Measurements.—Female holotype: length of carapace 6.4 mm., width 6.8 mm. Male paratype: width 4.7 mm., length 4.7 mm.

Range.—Length of the Gulf of California.

Material examined.—Miramar Beach, near Guaymas, Sonora, December 23, 1931: 3 females, 1 male, collected by the author. The types were selected from this small series. Also one specimen was collected at each of the following localities: Espíritu Santo Island, Gulf of California, December 6, 1931; Carmen Island, Gulf of California, January 21, 1932; Seargent's Point, Sonora, January 2, 1932; Punta Peñasco (Rocky Point), Sonora, May 3, 1935.

Habitat.—This appears to be a shore form occupying the lower intertidal zone with *P. sinuimanus* Lockington, but is not plentiful at any locality.

Remarks.—This proposed species is allied to *P. sinuimanus* Lockington, 1878, but differs from that species by the shape and form of the carpus of the chelipeds, and by the carpus not being armed on its inner margin with a proximal lobe. It differs also in that the upper surface of the carpus is flattened instead of rounded as in *P. sinuimanus*.

That Lockington was sensible to a difference between this species and *P. sinuimanus* is evident, but he attributed this difference to a variation in his species. He was no doubt influenced in his judgment by a lack of material. To quote from his notes (the italics are mine): "This species varies considerably: *some few specimens are without a trace of the lobe upon the meros or of the tooth upon the anterior margin of the carpus;* in others they are small, in others large and prominent. *One specimen combines with the want of these teeth a carapax the surface of which is plicate upon the margins.* The rolling ridges of the manus and carpus, and the deeply punctate surface of both, are constant characters."

This species is named in honor of Sidney I. Smith, whose work in carcinology on the west American coast added so much to our knowledge of this fauna.

Pisosoma lewisi, new species

Type.—Female, holotype, Cat. No. 774, San Diego Society of Natural History; male, paratype, Cat. No. 775, S. D. S. N. H.: from Tenacatita Bay, Jalisco, Mexico, low tide; December, 1932; collected by Captain Fred O. Lewis, of the yacht "Stranger."

Diagnosis.—Carapace subquadrate, as wide as long, punctate. Chelipeds heavy; carpus short, wide, deeply bisculate; hands heavy, trisulcate.

Description.—Carapace depressed, subquadrate, convex anteriorly, punctate; lateral margins subparallel, plicate, with plications continuing but a short distance on dorsal surface; front trilobed, not strongly advanced, median lobe depressed, triangular, with a deep median sulcus continued from the gastric regions; protogastric lobes distinct; anterior to these are another pair of lobes, transversely striate; these lobes are separated from the raised, transversely striate ocular margins by deep sulci which join the anterior hepatic sulcus posterior to the eye; a transverse plicated hepatic lobe, laterally margined by an anteriorly distinct cervical groove; on each side of the cardiac region is a crescentic whorl, opening posteriorly. The eye stalks are large, the cornea is small. Antennal peduncles heavy, stout, unarmed.

Chelipeds heavy, stout, subequal, granulate, tuberculate, rigid and deeply furrowed; merus stout, with carpal articulation transversely straight, armed at anterior distal end with a high granulated lobe; carpus including teeth, nearly as wide as long, short, wide (length 3.9 mm., width 3.3 mm.), armed on anterior margin with three or four stout, granulated, blunt, conical teeth, the distal the smallest; the carpus is deeply furrowed by two wide grooves, dividing the upper surface into three wide crests; the anterior and median crests are composed of obliquely placed, close set, rounded plications, or, in other specimens, these ridges are formed of a pavement of close set granulations; these two ridges are connected at the proximal end, open distally; the third ridge, on the outer margin, is not connected with the other two and is composed of obliquely placed tubercles and granules, which continue for a short distance on the ventral side; the hands are heavy, short, distorted, thick, with three longitudinal, deep, wide, granulated furrows, the median not separating its marginal ridges proximally; these two ridges thus form a long V, they being high, rather flat on top and composed of thickly crowded granules; the outer margin on the upper surface is a tumid, obliquely plicated ridge; these close set, beaded plications are scarcely continued on the inner side of the palm; the fingers of the major hand are short, thick, blunt, not crossing at the tips; the dactyl is armed with a large proximal lobe; the fingers of the minor hand are contorted, furrowed, granulate, with tips crossing.

Ambulatory legs short, heavy; merus wide, compressed; carpus, propodus and dactylus clothed with short, sparse setae; under side of propodi and dactyli armed with a row of short, sharp spines.

Sexual variation.—In the female the abdomen covers the sternum, in the male it does not. The sex may be determined at a glance by noting the relative difference in the size of the plates of the telson, those of the female being much the larger.

Color in alcohol.—A uniform light red.

Measurements.—Female holotype: length of carapace 5.5 mm., width 5.5 mm. Male paratype: length 4.9 mm., width 4.8 mm.

Range.—West Mexican coast, from Acapulco to Tenacatita Bay.

Material examined.—Three males, one female, from Tequepa Bay, N. of Acapulco, Guerrero, December 18, 1932, collected by Captain Fred O. Lewis, of the yacht "Stranger." One male and two females, from Tenacatita Bay, Jalisco, December, 1932, collected by Captain Fred O. Lewis. The type specimens were selected from this latter series.

Habitat.—Littoral.

Remarks.—This proposed species is allied to *P. curacaoensis* Schmitt, in the general shape of the carapace and chelipeds. It differs from that species in the carpus being bisculate, instead of trisculate, by the hands being deeply trisculcate, instead of fairly smooth, and by the hands being nude, instead of with a peculiar bunch of tomentum on the upper surface. The carapace of *P. lewisi*

greatly resembles that of the figure of *Petrolisthes quadratus* Benedict (Bull. U. S. Fish Comm., vol. 20, pt. 2, 1900 [1901], pl. 3, fig. 4).

This species is dedicated to Captain Fred O. Lewis of Newport Beach, California, from whose yacht "Stranger" the specimens were collected.

Pisosoma erosa, new species

Type.—Female, holotype, Cat. No. 71539, and male, paratype, U. S. National Museum: from Magdalena Bay, Baja California, Mexico, 12 fathoms; December 2, 1931; collected by Steve A. Glassell. Female and male paratypes, Cat. Nos. 776 and 777, S. D. S. N. H.; from same series.

Diagnosis.—Carapace suboval, convex, heavily eroded on margins. Carpus of chelipeds and ambulatories heavily eroded.

Description.—Carapace subcircular, about as wide as long, convex fore and aft, regions outlined with sulci; branchial regions heavily eroded, lined and pitted; posterior third with prominent, outstanding, transverse carina, converging and ceasing at borders of intestinal region; antero-lateral margins forming a decided subcrenulate, granulated ridge; gastric regions lobed. Front in dorsal view subtruncate, entire, with a median sinus, in a front view, sharply upturned for the antennules. Eyes small.

Chelipeds short, heavy; ischium pitted and toothed; merus reticulated, pitted and eroded, a gnarled granulated lobe at distal inner end; carpus a third longer than wide, armed with a single, proximal, serrated tooth on inner margin, granulated serrations on outer surface, reticulated, eroded, pitted and scored, pits bordered with granules, under surface transversely striate, pitted; hands with two granulated ridges from proximal end to base of fingers; on both sides of these, toward the margins, are reticulations and granulate bordered pits and erosions; pollex with a granulate tumid ridge supporting its cutting edge; dactyli with a longitudinal median sinus, granulate; fingers close fitted; under side of hands rough.

Ambulatory legs with merus sharp crested, granulate; carpus sharply ridged and eroded, as is the propodus; dactyli rather long, slightly curved at tip and with a row of supplementary spines on under surface.

Abdomen fringed with hair.

Color in alcohol.—A light pink.

Measurements.—Female holotype: length of carapace 5 mm., width 5.2 mm. Male paratype (a small specimen): length 3.4 mm., width 3.4 mm.

Range.—Magdalena Bay, Baja California, and Gulf of California.

Material examined.—Two males and two females, taken at Magdalena Bay, December 2, 1931, 12 fathoms, by the author. The types for this species were selected from this material. Two small specimens from the north end of Tiburón Island, Gulf of California, January 1, 1932, 20 fathoms, collected by the author.

Habitat.—Evidently not a shore form, as it has so far been taken only in depths ranging from 5 to 20 fathoms.

Remarks.—This proposed species is allied to *P. sinuimanus* Lockington, 1878, but differs from that form in the extreme roughness of its surfaces and by the hands being less thick.

The difficulty of obtaining undamaged specimens is due not only to its small size, but also to the hard materials which are brought up in the dredge with it.

Pachycheles marcortezensis, new species

Type.—Female, holotype, Cat. No. 71540, and male, paratype, U. S. National Museum: from off SE end of Angel de la Guardia Island, Gulf of California, Mexico, 20 fathoms; January 8, 1932; collected by Steve A. Glassell. Female paratype, Cat. No. 778, S. D. S. N. H.; from same series. One male paratype, in the collection of Steve A. Glassell, Beverly Hills, California.

Diagnosis.—Carapace convex fore and aft, having scattered, short bristles on anterior 2/3 to orbital area, orbital area covered with short, sparse tomentum. Carpus with three long and two shorter, falcate spines. Telson of abdomen with five plates.

Description.—Carapace wider than long, convex fore and aft, regions lightly outlined, scattered bristles, single and small groups on anterior 2/3; front covered with sparse, short tomentum, subtruncate in dorsal view, sinuous in front view; a sharp postocular spine separates the eye from the antennae; anterior margin with a distinct carina which comes onto the carapace a third of the distance from the posterior border. The first antennal peduncle is armed distally with a sharp, forward-pointing spine, the second is armed with two spines, one median, one distal.

The chelipeds are subsimilar though unequal; merus short, with a distinct distal, anterior, spinose lobe, carpal articulation tuberculate, lined with bristles, a sharp spine at distal ventral terminus; carpus short, with four or more rows of longitudinally placed tubercles, those on the posterior half having radiating setae; the anterior half is covered with flat, squamoso-granulated, bristle-bearing groups; the anterior margin armed with three large scythe-like, forward- and outward-pointing teeth and two smaller distal teeth; hands triangular, short, thick, covered on the outer surface with lobes and bristle-bearing tubercles, and armed on outer margin with a close-setting row of short, dull-pointed teeth; inner surface punctate, with more roughness near outer margin; fingers with a slight gape, tips curved, overlapping.

Ambulatory legs short, slightly setose; merus wide; carpus and propodus stout, with longitudinal rows of squamae, bearing bristles; dactyli short, heavy, curved, tips corneous, under side with several corneous spines; merus of second ambulatory leg has a few transverse striae on inner surface.

Abdomen with five plates on the terminal segment.

Color in alcohol.—Red mottled with white; bristles a straw color.

Measurements.—Female holotype: length of carapace 4.8 mm., width 5.2 mm. Male paratype: length 3.7 mm., width 3.7 mm.

Range.—Gulf of California, at one time called the Sea of Cortez.

Material examined.—Two females and two males, dredged off the SE end of Angel de la Guardia Island, Gulf of California, January 8, 1932, in 20 fathoms, by the author. The type specimens are from this series.

Habitat.—Evidently not a shore form.

Remarks.—This proposed species is allied to *P. rugimanus* A. M. Edwards, 1880, but differs in that it has five teeth on the carpus instead of three or four, and these are longer in the first three and more hooked at their tips; also the entire surface of the chelipeds is covered with setae instead of being simply granulated and furrowed.

Pachycheles sonorensis, new species

Type.—Male, holotype, Cat. No. 71541, and female, paratype, U. S. National Museum: from Miramar Bay, near Guaymas, Sonora, Mexico, low tide; December 23, 1931; collected by Steve A. Glassell. Two paratypes, male and female, Cat. Nos. 779 and 780, S. D. S. N. H.; from same series.

Diagnosis.—Chelipeds unequal, covered with short and long bristles. Carapace smooth in central area, punctate, with small bristles on remaining portions. Telson composed of seven plates.

Description.—Carapace nearly as long as wide, subquadrate; punctate and sparsely bristled to central area, which is smooth; a pair of transverse, setose ridges behind the frontal region; front depressed, margined with short bristles, convex, not tomentose. First antennal peduncle rough at distal end, the others smooth.

Chelipeds unequal; merus with a large anterior, distal lobe, upper surface rugose, sparsely bristled; carpus short, wide, tuberculate on proximal third and posterior border, the entire surface covered with squamae, bearing a group of short bristles; anterior margin tridentate in an arc; hands covered as in carpus, longest bristles on outer margin; inside of palm with tubercles and squamae except for central portion, tuberculate and with long bristles on inner gape of major hand; fingers of major hand unarmed, gaping; of minor hand, dentate, close-fitting, hooked at tips.

Ambulatory legs short, heavy, sparsely covered with bristles; dactyli long, curved at corneous tip, armed on under side with a row of supplementary spines.

Telson with seven plates, as in *P. pubescens* Holmes, 1900.

Color in alcohol.—Red mottled with white; bristles a straw color.

Measurements.—Male holotype: length of carapace 7 mm., width 7.5 mm. Female paratype, length 7.6 mm., width 8 mm.

Range.—Known from type locality only. Gulf of California.

Material examined.—A series of nearly a hundred specimens of both sexes, from Miramar Bay, Sonora, December 23, 1931, collected by the author.

Habitat.—Found at low tide, under moss and sponge incrusted stones.

Remarks.—This proposed species is allied to *P. setimanus* (Lockington), 1878, both as to size and general appearance, and in also having 7 plates in the telson; but it differs in a marked degree by not being tomentose, but setigerous instead, by having the inner side of the hand roughened and setose in the gape, instead of smooth and in having the first antennal peduncle rough at its distal end, instead of smooth.

It seems remarkable that this species was not obtained at other collecting stations in the Gulf of California, where similar collecting conditions were found.

Porcellana cancrisocialis, new species

Type.—Male, holotype, Cat. No. 71542, and female, paratype, U. S. National Museum: from Punta Peñasco (Rocky Point), Sonora, Mexico, low tide; May 2, 1935; collected by Steve A. Glassell. Two paratypes, male and female, Cat. Nos. 781 and 782, S. D. S. N. H.; from same series.

Diagnosis.—Carapace slightly convex, sides slightly rounded. Front sharply tridentate. Shoulder posterior to terminus of cervical groove armed with a row of fine teeth. Lower orbital margin armed with a long, sharp, forward-pointing tooth. Hands tomentose.

Description.—Carapace slightly convex in both directions, highest in central regions, with a polished appearance, but with front tomentose; transverse ridge behind front lined with tomentum; several short, transverse striations on branchial regions, tomentose. Front sharply tridentate, horizontal, median tooth equilaterally triangular, largest, and separated from the laterals by a deep V-shaped notch; the outer margin of the lateral teeth forms the upper ocular margin in a long sweeping curve; the lateral teeth are sharp-pointed and nearly as long as the median tooth. The eyes may be partly retracted under the shelter of the upper ocular margin, which ends in a sharp-pointed postorbital tooth. The lower ocular margin extends forward, forming a flat, sharp, horizontal tooth at its inner angle, which extends as far forward as the base of the median rostral tooth. A shoulder at the posterior terminus of the cervical groove; this shoulder extends from the margin a short distance onto the carapace and is armed on its anterior margin with a series of sharp denticles. The posterior margin of the carapace is nearly straight.

Chelipeds short, stout, subequal, the left hand usually the larger; merus short, dorsally triangular, with a vertically compressed plate-like process armed

on its forward surface with sharp thin teeth; on its distal inner end, this process terminates below the plane of the upper part of the carpus; the carpus is short and broad, about as wide as long, armed with a single, flattened, sharp-pointed tooth which occupies the proximal third of the inner margin, lightly transversely striate, with tufts of tomentum posteriorly; hands curving outward on both margins, short, thick, convex on upper surface, fingers heavier than pollices, covered on outer half with long pinnate tomentum; outer margin granulate-serrate.

Ambulatory legs stout; merus wide, crested with a few setae as are the carpus, propodus and dactylus; dactyli curved at the corneous tip and with a row of supplementary spines on the lower margin.

Color in life.—Ground color an ivory yellow, overcast with lavender and blood red spots. Protogastric regions lighter (white in alcohol). Chelipeds same as carapace. Ambulatory legs banded on propodus with white.

Measurements.—Male holotype: length of carapace 5.7 mm., width 4.8 mm. Female paratype: length 5.4 mm., width 4.8 mm.

Range.—Gulf of California to Magdalena Bay, Baja California.

Material examined.—Thirteen specimens of both sexes were collected by the author at Punta Peñasco (Rocky Point), Sonora, May 2, 1935. From this series the type specimens were selected. Three specimens were collected by the author at San Felipe, Baja California, June 20, 1936.

Habitat.—This species, like *P. paguriconviva,* is commensal with the large Pagurid, *Petrochirus californiensis* Bouvier, 1895, and enjoys the same association. Usually a single pair occupies a shell, but one or three may be present.

Remarks.—This proposed species is allied to *P. sayana* (Leach), 1820, but differs from that species in that the base of the antennae is armed with spines instead of being smooth, by the hands being more covered with hair and tomentum, and by the tip of the rostrum not being decurved. Specimens so far are scarce.

Porcellana paguriconviva, new species

Type.—Male, holotype, Cat. No. 71543, and female, paratype, U. S. National Museum: from Punta Peñasco (Rocky Point), Sonora, Mexico, low tide; May 1, 1935; collected by Steve A. Glassell. Two paratypes, male and female, Cat. Nos. 783 and 784, S. D. S. N. H.; from same series.

Diagnosis.—Carapace smooth, or with tomentum on front. Front tridentate, the median tooth largest, triangular, equilateral. Chelipeds with carpus unarmed; hands dorsally flat, wide, fringed on outer margin or nude.

Description.—Carapace longer than wide, depressed, sides subparallel, regions ill-defined. Front horizontal, tridentate, the median tooth the largest and most prominent, triangular, equilateral (almost as in *Petrolisthes,* except not

depressed, and without a median sulcus), the lateral teeth truncate in front, forming a right angle with the upper ocular margin; the ocular margin partly covers the eyes. There is a postocular tooth; a shoulder behind the terminus of the cervical groove, unarmed; a pair of lunate pits between the gastro-cardiac regions. There may or may not be tomentum on the frontal region, usually not more than microscopic.

The chelipeds are short and heavy, depressed on upper surface; the merus is short, the distal inner end with a blunt compressed upward-pointed lobe; the upper surface of the merus is triangular, widest posteriorly, its apex the hinge of the carpus; the carpus is short, wide, flattened, lightly rugose, widest at proximal end, at which point it is as wide as long, 2 mm.; the hands are short, stout, microscopically rugose, flattened on upper surface, subequal, with tips of pollices slightly upturned; dactyli with truncate, flattened tips, crossing tips of pollices on inner margin, one hand slightly the larger, outer margin fringed with tomentose hair, or nude.

Ambulatory legs short, stocky, margined with tomentum and light setae; dactyli stout, curved at corneous tip, armed on under surface with a row of supplemental corneous spines.

Color in life.—Ground color, in longitudinal stripes, a bright lavender, a uniform design of bright orange overlaid on this. Chelipeds same as carapace, but not patterned; legs with a white spot on propodus. Ventral side iridescent, pinkish white, with longitudinal pattern of carapace continued on first three segments of abdomen.

Measurements.—Male holotype: length of carapace 5.8 mm., width 5.1 mm. Female paratype: length 5.6 mm., width 5.1 mm.

Range.—Gulf of California.

Material examined.—A series of about 25 specimens, collected by the author, at Punta Peñasco (Rocky Point), Sonora, May 1, 1935.

Habitat.—These little crabs are commensal with the large hermit crab, *Petrochirus californiensis* Bouvier, 1895. The usual association is: the Pagurid host, occupying the shell of *Phyllonotus nigritus* (Philippi), accompanied by a large Pollonoid worm and a pair of these little Porcellanids. At times the inner face of the shell may have a *Crepidula nivea* Gould, attached, and this in turn may be commensalized with the Pinnotherid, *Fabia granti* Glassell.

Remarks.—This proposed species is allied to *P. sayana* (Leach), 1820, but differs from that species in the shape of the front, which does not have its lateral teeth separated from the angles of the orbits by deep incisions. Also in that the carpus of the chelipeds in this species has its inner margin in an unbroken oblique line, while *P. sayana* has a proximal lobe on the inner margin. In this species there may be individual variations in the size and shape of the lateral teeth of the front, some protruding a little more than in the holotype and having a rounded sinus on the margin at the base of the median tooth.

Porcellana magdalenensis, new species

Type.—Female, holotype, Cat. No. 71544, U. S. National Museum: from Magdalena Bay, Baja California, Mexico, 12 fathoms; December 2, 1931; collected by Steve A. Glassell. One paratype female, Cat. No. 785, S. D. S. N. H.; from same series of 5 specimens.

Diagnosis.—Carapace nearly as long as wide, suboval, convex, regions defined; lateral, hepatic and upper and lower ocular margins dentate. Front trilobate, margined with denticles. Chelipeds with median longitudinal ridges, dentate. Legs long.

Description.—Carapace suboval, regions defined, convex, crossed with transverse rugae; protogastric lobes distinct, with anterior border prominent, tomentose. Lateral margins bordered with sharp, forward-pointing spines that are continued onto the margin of the shoulder on the carapace, which is behind the terminus of the cervical groove; hepatic regions bordered with forward-pointing spines, the proximal the largest; the front has three dentate lobes; the median triangular, with a median sulcus and slightly depressed at the tip; the lateral lobes are rounded at their apices, separated by a wide V-shaped groove from the median lobe, the outer margin extending backward, forming the upper ocular margin. The frontal lobes and both the upper and lower ocular margins are lined with small sharp teeth.

The chelipeds are long and narrow, subequal; merus fringed with small teeth on upper carpal articulation, and having a wide, compressed, inner distal lobe, fringed with teeth, and one or more teeth at ventral distal angle; carpus longer than wide, armed on inner margin with a row of small, sharp teeth, the proximal ones the largest; a median spinate ridge, the surface between this ridge and the inner margin lightly tomentose and concave, while toward the outer margin the surface between the median ridge and a row of spines parallel to the outer margin is convex and rugose; the hand is narrow, the outer margin concave, lined with spines and fringed with pinnate tomentum; a median spinate ridge from proximal end to base of dactylus is bordered by two concave surfaces; fingers long, half the length of the hand, contorted; pollex terminates in a sharp, slightly upturned point; dactylus with upper margin toothed, a short median spinate ridge between this and the prehensile edge; a fringe of pinnate tomentum veils the cutting edge.

Ambulatory legs long, fairly slender; merus crested with short setae, transversely rugose; propodus long, cylindrical, with a few setae; dactyli long, compressed, curved, with needle-like tips.

Epistome heavily plicated.

Sexual variation and color in life.—Unknown.

Measurements.—Female holotype (left cheliped missing): length of carapace 4.5 mm., width 4.6 mm.; length of hand 5 mm.; width at base of finger 1.5 mm.; length of fingers 2.5 mm.; length of carpus 2.5 mm., width 1.5 mm.

Range.—Known only from type locality.

Material examined.—Five female specimens, collected in Magdalena Bay, Baja California, in 12 fathoms, by the author. The ovigerous holotype for this proposed species is the largest of the series.

Habitat.—Evidently among sponges and corallines.

Remarks.—This species is allied to *P. serratifrons* Stimpson, 1858, but differs from that species in the shape of the front, the median lobe being triangular instead of rounded, with the lateral lobes but little less in width, instead of subacute and scarcely less prominent. The chelipeds are more heavily spined in this species than on *P. serratifrons* and, in addition, the hands are fimbriate with tomentum.

ORTHOCHELA, new genus

Carapace longer than wide, transversely convex; front horizontal, truncate, except for a prominent, median, equilateral, rostral protuberance; the front nearly as wide as the carapace; lateral margins of the carapace subparallel, armed with short, sharp, forward-pointing spines, terminating at cervical shoulder. Eyes large, stalks thick, short; may be semi-retracted under lateral edge of ocular margin. Antennae partly excluded from orbit, nearly as long as chelipeds; flagellum naked. Chelipeds subsimilar, unequal, directed forward, as in the Galatheidae, length about 2½ times the length of the carapace; merus extends past the rostrum; carpus and hand long, cylindrical; fingers short, opening vertically. Ambulatory legs short, propodi longer than merus, dactyli curved at tip, simple, not multiunguiculate. Terminal segment of abdomen with seven plates.

This genus has a remote affinity to the genus *Minyocerus* Stimpson, 1858, which is based on *Porcellana angusta* Dana, 1852, in which the chelipeds are somewhat similar. The carapace, however, differs from all the other genera in this family and is more like that of the genus *Uroptychus* Henderson, 1888, of the family Galatheidae.

Genotype.—*Orthochela pumila,* new species, taken at Magdalena Bay, Baja California, Mexico, 1 fathom, on yellow gorgonian coral (sea-fans), December 2, 1931, by Steve A. Glassell.

Orthochela pumila, new species

Plate 21, figure 1

Type.—Male, holotype, Cat. No. 71545, and female, paratype, U. S. National Museum: from Magdalena Bay, Baja California, Mexico, 1 fathom; December 2, 1931; collected by Steve A. Glassell. One paratype male, one paratype female, Cat. Nos. 786 and 787, S. D. S. N. H.; from same series.

Diagnosis.—Carapace subquadrilateral, margins spinous, front unidentate,

truncate to width of carapace from base of rostrum. Chelipeds forward-pointing, long, cylindrical, fingers moving in a vertical plane.

Description.—Carapace subquadrilateral, longer than wide, transversely convex, cervical groove ill-defined, surface polished, hard, microscopically punctate; lateral margins armed with a row of closely set, forward-pointing spines, terminating at the shoulder behind the cervical groove. Posterior margin straight, entire. Front truncate, wide, extending nearly the width of the carapace, where it turns backward in a curved line, thence runs tangent to its former direction, finally sweeping outward to form the postorbital tooth which covers the first antennal peduncle; the rostrum is a large, truncate-tipped, equilateral triangle whose base is the line of the front; it is armed at its truncate apex with a row of short, sharp, protruding teeth; the lateral margin of the truncate front, anterior to the eyes, is also minutely toothed. The antennae are long, naked, and may be pointed in a direction either straight forward or straight backward. The eyes are large, with stout, short stalks, and may be retracted until half of the cornea is visible beneath the upper ocular margins.

The chelipeds are subsimilar, unequal, directed forward and in large specimens may be 2½ times the length of the carapace; the merus extends past the tip of the rostrum; the length of the carpus is about equal to the width of the carapace, half as wide as long, subcylindrical, smooth and having a concavity at its distal inner end for the partial reception of the hand; the major hand is nearly twice the length of the carpus, cylindrical, with the fingers in a vertical plane; the fingers are short, being a trifle more than 1/5 the length of the hand; the pollex is serrated with teeth on its outer distal margin; the fingers of the minor chela are longer in proportion, and not so heavy.

The ambulatory legs are bent underneath the body in a grasping position; the merus is short, compressed, on the anterior margin ending distally with a high, sharp outward-pointing tooth; the carpus is short; propodus long and slightly curved, longer than the merus; the dactyli are long, curved at tip and armed on the under side with a row of supplementary spines, simple, not multiunguiculate.

The outer maxillipeds have the ischium lightly crossed with transverse striae.

The ultimate segment of the abdomen has seven plates.

Sexual variation.—Apparently only a difference in size, the males with the longer and heavier chelipeds.

Color in life.—A rich yellow; lines of red on the hepatic regions. Hands with a few red blotches on outer surface; fingers with red bases and tips.

Measurements.—Largest male (this specimen had lost its minor cheliped): length of carapace 3.6 mm., width 2.8 mm.; length of major cheliped 9.8 mm.; length of hand 5.1 mm.; width of merus, carpus and hand approximately the same, 1.5 mm. Female paratype: length of carapace 3.8 mm., width 3 mm.; length of major cheliped 7.7 mm.; hand 3.2 mm.; carpus 2.2 mm.; merus and

ischium 1.3 mm.; length of first ambulatory leg 3.8 mm.; merus 1 mm.; carpus 0.5 mm.; propodus 1.5 mm.; dactylus 0.8 mm.

Range.—Known only from the type locality.

Material examined.—A series of both sexes, 35 specimens, collected at Santa Margarita Island, Magdalena Bay, Baja California, December 2, 1931, in 1 fathom, by the author.

Habitat.—These little crabs were found clinging to yellow gorgonian coral, along with Isopods and Amphipods, all of which harmonized so exactly in color with their host that they were to be distinguished only with difficulty.

Remarks.—This proposed species shows a rather close relationship to the members of the Galatheidae in the position of its chelipeds, and by having spinose lateral margins on the carapace. From their size, the location of their eyes, and the shape of the front, the specimens collected might be thought to be immature or even larval forms, if it were not that nearly all the females found were gravid.

PINNOTHERIDAE

Fabia unguifalcula, new species

Plate 21, figure 2

Type.—Female, holotype, Cat. No. 788, San Diego Society of Natural History: from Punta Peñasco (Rocky Point), Sonora, Mexico, low tide; May 3, 1935; collected by Steve A. Glassell. One female paratype, from same locality, in the collection of Steve A. Glassell, Beverly Hills, California.

Diagnosis.—Carapace with sides subparallel. Ischium-merus of outer maxilliped crescentoid, palp two-jointed. Dactyls of legs falcate. Hands short, wide, heavy; fingers dentate.

Description.—Carapace smooth, glossy, membranaceous, subtransparent, much wider than long, anteriorly arcuate, sides subparallel. Front turned abruptly downward. Eyes subovoid, cornea minute, not visible in a dorsal view. Basal joint of antennae short and wide. A narrow furrow leading backward from the buccal angle. Ischium-merus of outer maxillipeds crescentic, palp with two joints, ultimate segment wide, rounded distally.

Chelipeds stout, equal; merus short, not extending far past sides of carapace; carpus long, wide, rounded dorsally, inner proximal margin tomentose; hands short, wide, heavy, thick, smooth; lower margin sinuous; pollex slightly deflexed, with upturned, sharp-pointed tip, armed with a triangular-shaped cutting edge, with a median tooth and proximal denticles; dactylus long, falcate, armed proximally with a prominent denticulate tooth. Tips of fingers crossing.

Ambulatory legs paired, the first pair differing from the others in that the upper crest of the merus, the anterior lower margin of the carpus and propodus

are margined with tomentum. The dactyli of all legs are falcate, the fourth the least, the second the longest and sharpest.

The abdomen covers the sternum, is circular and fringed with hair.

Sexual variation and color in life.—Unknown.

Measurements.—Female holotype: length of carapace 4 mm., width 5 mm.

Range.—Known only from type locality.

Material examined.—Two ovigerous females, the larger the type, collected by the author at Punta Peñasco (Rocky Point), Sonora, May 3, 1935.

Habitat.—Collected in the inter-tidal zone. Association and host not determined.

Remarks.—This proposed species is allied to *F. granti* Glassell, 1933, but differs in that the front is nearly a continuation of the curve of the anterior margins, instead of being advanced; by the first ambulatory leg bearing tomentum, instead of being smooth and naked; and by the hands being short, stout, subquadrate and compact, instead of long and increasing in width distally. In addition, *F. granti* appears to be a much larger species.

Dissodactylus xantusi, new species

Plate 21, figure 4

Type.—Female, holotype, Cat. No. 71546, and male, paratype, U. S. National Museum: from Espíritu Santo Island, Gulf of California, Mexico, low tide; December 8, 1931; collected by Steve A. Glassell. Paratype, female, paratype, male, Cat. Nos. 789 and 790, S. D. S. N. H.; from same series.

Diagnosis.—Carapace convex fore and aft. Dorsal ridge short, oblique. Legs stout; dactyli of legs one to three bifurcate for almost half their length. Carpus with a transverse, setose, median ridge. Hand crossed on upper margin with three oblique, setose ridges. Terminal segment of male abdomen nearly an equilateral triangle. Palp of outer maxilliped three-jointed.

Description.—Carapace distinctly broader at lateral angles than posteriorly; lateral margins subequal, antero-lateral arcuate, postero-lateral straight, slightly concave posteriorly. Dorsal surface naked and polished, lightly punctate, convex fore and aft, slightly from side to side, depressions on metabranchial regions and margins of cardiac; a raised rim on antero-lateral margin sharply turns at lateral angle and continues obliquely on dorsal surface for a short distance. Margin of front slightly convex, slightly advanced beyond curve of antero-lateral margins; posterior margin sinuous.

Palp of outer maxilliped with three joints; the penultimate spatulate, truncate, with inner margin straight, with outer margin arcuate, widest distally; terminal

segment small, slightly advanced beyond line of penultimate segment and located on that segment's inner distal angle.

Merus of chelipeds extends but little beyond margin of carapace, upper distal margin setose; carpus as broad as long, crossed with an interrupted, transverse, median, setose ridge, the distal margin arcuate, setose; hands proximally swollen, upper crest straight, rounded, obliquely crossed by three distinct, setose ridges, the bristles pointing forward; the under margin has three light, oblique, setose ridges, the proximal the longest, a sparse row of long pinnate hair on inner surface to base of pollex; the outer surface is crossed with short, oblique, setose ridges, the distal ridge continuing on the base of the pollex; fingers long, close-fitting, with tips crossing.

Ambulatory legs slightly compressed, margined with fine, light hair; merus stout; carpus of first leg, only, with a longitudinal, sub-oblique ridge; the propodus has a sharp, setose crest, the bases of the bristles being just beneath this crest on the anterior side and pointing at right angles to the axis of the segment; dactyli of the first three legs bifurcate for nearly half their length; surface of legs highly polished, lightly punctate.

The abdomen of the female does not cover the sternum; the lateral margins of the segments, including the proximal half of the sixth, are subparallel; the terminal segment is broadly triangular, more than twice as wide as long. Male abdomen fused in third, fourth and fifth segments, widest at third, lateral margins converging to proximal half of penultimate segment, terminal segment an equilateral triangle. Surface of abdomen in both sexes highly polished, lightly punctate.

Sexual variation.—Hands of males heavier in proportion than those of the females. The females are the larger specimens.

Color in life.—A chocolate brown with a design of cream-colored lines and spots; the gastro-cardiac region divided by a transverse arcuate line, surmounted anteriorly by a broad V-shaped design. Legs with terminals of the joints banded with cream color; dactyli light-colored, as are the fingers of the hands; hands reticulated.

Measurements.—Female holotype: length of carapace 4.5 mm., width 6.1 mm. Male paratype: length 3.8 mm., width 4.9 mm.

Range.—Gulf of California.

Material examined.—Twenty specimens of both sexes were collected at Espíritu Santo Island, Gulf of California, December 8, 1931, by the author. The type specimens were selected from this series. Small series of both sexes were also collected by the author at the following stations: Las Animas Bay, Baja California, January 2, 1932; Coyote Cove, Concepción Bay, Baja California, January 18, 1932; San Felipe, Baja California, June 1, 1934; Punta Peñasco (Rocky Point), Sonora, May 2, 1935.

Habitat.—Commensal on the exterior ventral surface of Echinoids, such as *Mellita* and *Encope*. They are in close association with *D. nitidus* Smith; both species may at times be found on the same host.

Remarks.—This proposed species is allied to *D. nitidus* Smith, 1870, which it closely resembles, but from which it differs in the shape of the chelipeds, by the hands being rougher, the fingers stouter, by being naked under the pollex, instead of decorated with a tuft of thick black tomentum, and by the penultimate segment of the palp of the outer maxillipeds not having its lateral margins straight and parallel.

This species is dedicated to Louis John Xantus de Vesey, in appreciation of his character as a gentleman and of his attainments and zeal as a votary of natural history.

Pinnixa richardsoni, new species

Plate 21, figure 3

Type.—Male, holotype, Cat. No. 791, San Diego Society of Natural History: from Balboa, Canal Zone, Panama, upper tidal zone; February 22, 1936; collected by Frank Richardson.

Diagnosis.—Carapace twice as wide as long, regions deeply furrowed. Hand thin, compressed; fingers acuminate. Third leg longer than body width, heavy. Dactyli of ambulatories horizontally compressed. Third, fourth and fifth segments of male abdomen fused.

Description.—Carapace twice as wide as long, covered with very short setae; anterior and antero-lateral margins together forming a strongly convex arch, reaching to the widest part of the cardiac region and meeting the posterior angle at an obtuse angle; posterior margin transverse at its middle for 1/3 of carapace width. Gastric and cardiac regions delimited, the latter wider; three longitudinal, narrow gastric furrows, the median short, reaching half way back; branchial region crossed by four obliquely transverse furrows, the hinder one deep and parallel to the posterior margin. A short dorsal hepatic furrow is directed inward and forward. The antero-lateral margin is tuberculate distally. The eyes are small, dorsally placed, filling their orbits. The front is horizontal, truncate, entire, not extending past buccal area in dorsal view. Fronto-orbital width ¼ width of carapace.

Chelipeds small, longer than first leg; merus hairy, carpus and manus margined with long brown hair; carpus wide, compressed, with a high distal crest, outer surface covered with microscopic hair; hands thin, sharp-edged, compressed, not as wide as carpus, flat on outer surface, covered with minute hair, which, like those on the carpus, do not obscure the view of the surface; upper margin arched, lower margin straight; fingers narrow, longitudinal, acuminate, gaping in proximal two-thirds, movable finger crested with long hair, lower margin of

pollex nude. A median longitudinal fringe of long hair on inner side of carpus and hand. The inner proximal end of the pollex furnishes hair at the gape.

Ambulatory legs stout; the first is remarkable for the shape of its propodus and dactyl, the propodus being wide, short and heavy, its upper margin much the shorter; the dactyl is horizontally compressed, wide, short, crooked, upturned, its margins tangent to those of the propodus, as are the margins of the dactyli of the other legs; the third leg is very heavy, stout, 1/6 longer than the width of the carapace and 1/3 longer than the second leg; the merus is equal in length to that of the carapace, and nearly half as wide as long; there is a tubercle on the distal posterior surface of the carpus and propodus. The presence of a dense growth of tomentum and setae, covering the entire surface posteriorly, makes a close observation difficult; the dactyl is stout, heavy, dull-pointed, horizontally fringed with setae; the fourth leg reaches nearly to the end of the merus of the third leg.

The abdomen is widest at the third segment, very long and narrow, overlapping the buccal cavity; third, fourth and fifth segments regularly tapering, fused, sixth long and narrow, tapering, seventh long, rounded at tip which is margined with hair, sides converging. Ischium-merus of outer maxilliped with upper distal margin arched, a transverse line of hair located centrally.

Sexual variation and color in life.—Unknown.

Measurements.—Male holotype: length of carapace 6.5 mm., width 12.8 mm.; orbital width 3.2 mm.; transverse posterior margin 4 mm.; length of second leg 9.8 mm.; of third leg 15 mm.

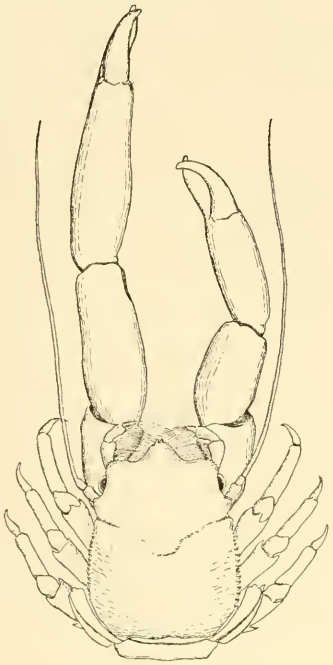
Range.—Known only from type locality.

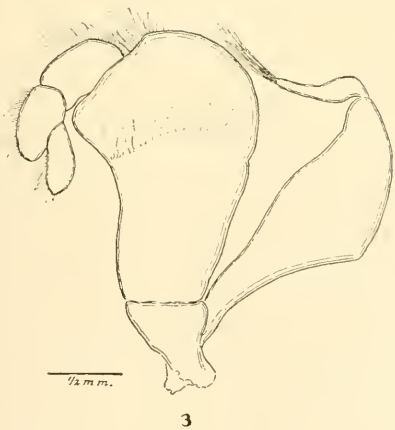
Material examined.—The single male specimen, the holotype.

Habitat.—Unknown. This specimen was dug out of heavy, thick mud in the upper tidal zone, from a small channel margined with mangrove trees. No host noted.

Remarks.—This proposed species is very closely allied to *P. valerii* Rathbun, 1931, but differs in the outer surface of the hands and carpus being smooth, instead of covered with tomentum (as is a topotype of *P. valerii,* before me); by the outer distal margin of the outer maxilliped being arched, instead of angular; and by some of the segments of the abdomen being fused, instead of articulated. Otherwise there are a great many similarities between these two unique species, which would seem to set them apart from other species of this genus with which I am familiar.

I take pleasure in dedicating this species to Mr. Frank Richardson, ornithologist, and graduate student of the University of California, to whom I am indebted for this specimen.





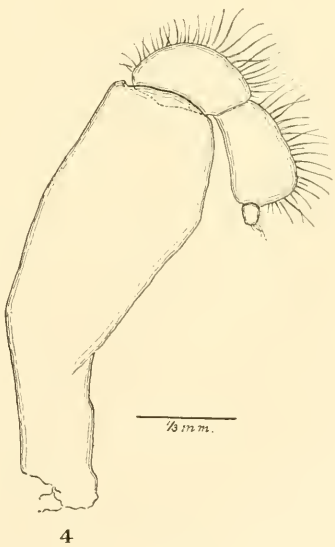


Fig. 1. *Orthochela pumila,* n. gen. and n. sp. Male.
Fig. 2. *Fabia unguifalcula,* n. sp. Outer maxilliped.
Fig. 3. *Dissodactylus xantusi,* n. sp. Outer maxilliped.
Fig. 4. *Pinnixa richardsoni,* n. sp. Outer maxilliped.

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WEST AMERICAN SPECIES OF THE GENUS PHOS

BY

A. M. STRONG AND H. N. LOWE
San Diego Society of Natural History

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WEST AMERICAN SPECIES OF THE GENUS PHOS

BY

A. M. STRONG AND H. N. LOWE*

San Diego Society of Natural History

Included among the shells dredged by the Templeton Crocker Expedition of 1932 off the west coast of Central America and Mexico were a large number of specimens of the genus *Phos*. These, and the specimens dredged by the junior author off Taboga Island, Panama; Acapulco, Mexico; and in the Gulf of California, Mexico, have added greatly to the amount of west coast material available for study. The large series of specimens of some of the species and representatives of many of the described forms in these collections seem to warrant a review of the genus as applied to the west coast.

The writers wish to express their appreciation to Mr. Templeton Crocker, whose generosity provided most of the specimens upon which this paper is based. Acknowledgment is also due Dr. G. Dallas Hanna, Curator of the Department of Paleontology of the California Academy of Sciences, for assistance and advice. The information regarding the records of the species occurring fossil in the Tertiary of western North America has been furnished to the authors by Dr. Leo G. Hertlein, of the Department of Paleontology, California Academy of Sciences, and Dr. U. S. Grant, IV, of the Department of Geology, University of California at Los Angeles. Dr. Alexander Wetmore, Assistant Secretary, Smithsonian Institution, kindly furnished photographs of certain specimens in the U. S. National Museum. These photographs were prepared under the supervision of Dr. Paul Bartsch, to whom west coast students are under obligation for many similar courtesies in the past.

The type of the genus *Phos* Montfort, 1810, *"Murex" senticosus* Linnaeus, is an Indo-Pacific shell. Woodring[1] stated that the West Indian and Panamic species are probably not congeneric. He considered the West Indian species to be descendants of the Eocene and

* H. N. Lowe, outstanding authority on west coast shells, died on June 10, 1936. The San Diego Society of Natural History, to which he bequeathed his large conchological collection, dedicates to his memory the publication of this paper, the last to bear his name.—*Editor.*

[1] W. P. WOODRING, Carnegie Inst. Washington, Publ. 385, 1928, p. 260.

Oligocene genus *Tritaria* Conrad and placed the Tertiary and living species in a new subgenus *Antillophos,* type *"Cancellaria" candei* d'Orbigny, Recent, West Indies. This species was united by Tryon with the west coast *Phos veraguensis* Hinds, which, while undoubtedly distinct, is closely related. For a thorough study of the entire group, world wide material, both fossil and living, would be required; so for the purpose of this paper the name *Phos* is used as it was by the older monographers.

Recent species of the genus on the west coast seem to be limited to tropical waters, Gulf of California to Panama. Nearly all of the records are from dredged material in depths ranging from 20 to 100 fathoms. Little dredging has been done in this area and the literature on the various species is limited. Hinds described and figured four species in the portion of the Zoology of the Voyage of the Sulphur dealing with Mollusca. In addition to these, one species described by Reeve, one by Carpenter, one by A. Adams, one by Powys as a *Nassa,* and one by C. B. Adams as a *Triton* make up the list from the older works.

Dall,[2] in his "Summary of the Family *Alectrionidae* from the West Coast of America," cited under the genus *Phos* only one of these older species, *Phos crassus* Hinds. In this and other papers he described a number of new species, either as *Phos* or which should be referred to *Phos.* Several of these were unfigured, but the types in the U. S. National Museum have been examined by the junior author. Some of these are here placed in synonymy with species described by Hinds. A study of the large number of specimens now available shows that the character of the nuclear whorls, presence or absence of a columellar keel, and dentition of the outer lip are specific characters. The color, number of ribs, and details of sculpture are more variable.

In the following pages all species of *Phos* for which we have been able to find west coast records are mentioned. The genus is described in Zittel's[3] Text-book of Palaeontology as follows:

"Shell elongate, bucciniform, turriculate; spire sharp, elevated, whorls ornamented with prominent longitudinal costae, and less salient

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2 W. H. Dall, Proc. U. S. Nat. Mus., vol. 51, no. 2166, 1917, p. 578.

3 W. H. Dall in Text Book of Palaeontology adapted from Karl A. von Zittel by Charles R. Eastman, vol. 1, 1913, p. 556.

spiral threads and sulci, often varicose. Aperture oblong, outer margin lirate within. Columella excavated, plicate in front; canal short, slightly twisted."

Phos articulatus Hinds

Plate 22, figure 6

Phos articulatus HINDS, Zool. voy. *Sulphur,* vol. 2, Moll. pt. 2, October 1844, p. 38. "Panama."—Sowerby, Thes. Conch., vol. 3, (pt. 19), 1859, p. 91, pl. 221, fig. 32. "Panama."—Tryon, Man. Conch., vol. 3, 1881, p. 218, pl. 83, fig. 516. Panama; western Colombia.

Phos turritus A. ADAMS, Proc. Zool. Soc. London, 1850, p. 154. "Panama, coral sand, 6 to 10 fathoms."—Sowerby, Thes. Conch., vol. 3, (pt. 19), 1859, p. 91, pl. 221, fig. 37. Original record cited.—Tryon, Man. Conch., vol. 3, 1881, pl. 83, fig. 517.

Specimens were dredged by the Templeton Crocker Expedition at the following localities:

Loc. 27587 (C. A. S.), off Cape San Lucas, Lower California, Mexico, near big rocks, in 20-25 fathoms.

Loc. 27585 (C. A. S.), Lat 23° 02′ N., Long. 109° 32′ W. A few miles off shore at Gorda Point, in San José del Cabo Bay, Lower California, Mexico, in 20-25 fathoms.

Loc. 27581 (C. A. S.), between Isabel Island and Mazatlan, Sinaloa, Mexico.

Loc. 27571 (C. A. S.), Lat. 16° 39′ N., Long. 99° 24′ 30″ W., to Lat. 16° 38′ N., Long. 99° 27′ 30″ W. About 33 miles slightly east of Acapulco, Guerrero, Mexico. This is about 32 miles west of Dulce Bay.

Loc. 27568 (C. A. S.), Lat. 14° 52′ N., Long. 93° 04′ W., in 35 fathoms. About 23 miles west of San Simón Bar, Mexico.

Loc. 27566 (C. A. S.), Lat. 14° 25′ N., Long. 92° 28′ W., in 35 fathoms. About 28 miles west of Champerico, Guatemala.

A free translation of Hinds' original Latin description is as follows:

"Shell elongate-ovate, white, clouded with brown, whorls rounded, ribbed; with spiral lines; below the suture flatly sloping to an angular shoulder; articulated with narrow whitish brown bands; with about 14 ribs at the periphery, sometimes swollen; columella smooth."

To this can be added that the nucleus consists of five spirally threaded whorls and that the outer lip is dentate. *P. turritus* A. Adams was also described from Panama. Tryon stated that it is the same as *P. articulatus* Hinds and there is nothing in the descriptions or figures to indicate that they can be separated.

Phos chelonia Dall

Plate 22, figure 3

Phos chelonia DALL, Proc. U. S. Nat. Mus., vol. 51, 1917, p. 578. "Dredged at the Galapagos Islands in 40 fathoms."

Dall's description of this species is as follows:

"Shell very similar in general appearance and size to *P. varicosus* Gould, having similar whitish varices, about three or four to a whorl, but differing by having the whorls appressed to the suture, not deeply impressed, and in having a nuclear shell of five or six whorls, deeply spirally sulcate instead of a nearly smooth one of three and a half whorls. The color of the present species is pale yellowish with a tinge of brown, as in *varicosus,* which also has narrower and more numerous ribs between the varices."

Phos varicosus Gould[4] was described from the Philippines and is said by Tryon[5] to be a synonym of *P. roseatus* Hinds from the same region. *Phos chelonia* differs from the other species described from the west coast in the presence of the whitish varices. No specimens that could be referred to this species were collected by either the Templeton Crocker Expedition or the junior author.

Phos cocosensis Dall

Plate 22, figure 7

Phos cocosensis DALL, Proc. U. S. Nat. Mus., vol. 18, April 23, 1896, p. 11. "U. S. Fish Commission station in 66 fathoms, near Cocos Island, Gulf of Panama."—Dall, Bull. Mus. Comp. Zoöl., vol. 43, no. 6, 1908, p. 306, pl. 8, fig. 5. Near Cocos Island, Gulf of Panama. Also at U.S.S. *Albatross* Sta. 3387, in 127 fathoms.—Dall, Proc. U. S. Nat. Mus., vol. 51, 1917, p. 578. "Gulf of Panama, Cocos Island, (Gulf of California?)."—Zetek, Rev. Nueva, nos. 1 & 2, 1918, p. 22.

Dall gave the type locality as near Cocos Island, U.S.S. *Albatross* Sta. 3368 in 66 fathoms. He also listed the species from U.S.S. *Albatross* Sta. 3387, in 127 fathoms and in a later paper he cited it questionably from the Gulf of California. His original description is as follows:

"Shell elongate, acute, eleven-whorled, including a nucleus of four whorls; color yellowish white, with variable brown spiral banding; sculpture of eleven or twelve narrow, little elevated, distant ribs, more or less angulated at the shoulder; spiral sculpture of numerous rather sharp, close threads, flatter on the last whorl, with a few more prominent between the suture and the shoulder; sutures distinct, whorls moderately rounded; aperture longer than wide, with an entire outer lip,

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[4] A. A. GOULD, Proc. Boston Soc. Nat. Hist., vol. 3, 1849, p. 143. "Philippine Islands." —GOULD, Otia Conch., 1862, p. 66.—GOULD, U. S. Explor. Exped., (Wilkes Exped.), Moll. Atlas, 1856, pl. 20, figs. 360, 360a.

[5] G. W. TRYON, JR., Man. Conch., vol. 3, 1881, p. 217, pl. 83, fig. 511.

slightly thickened and internally lirate; throat white, pillar with a groove near its anterior edge; canal short, deep; siphonal fasciole moderate; body with a thin white callus. Height, 47; last whorl, 28; diam. 19 mm."

In size and in the shouldered whorls this species is quite similar to *P. articulatus* Hinds, but it seems to differ in the details of the sculpture and in the apparently smooth nuclear whorls. According to Dall, *P. cocosensis* differs from *Phos beaui* Crosse & Fischer, of the West Indies, in the greater size and in the strong regular ribs. No specimens collected by the Templeton Crocker Expedition or the junior author have been referred to the species.

Phos crassus Hinds

Plate 22, figure 10

Phos crassus HINDS, Ann. & Mag. Nat. Hist., new ser., vol. 11, no. 70, April, 1843, p. 257. "Panama and Gulf of Fonseca; dredged as solitary shells in from 3 to 14 fathoms, mud."—Hinds, Zool. Voy. *Sulphur,* vol. 2, Moll. pt. 2, October 1844, p. 37, pl. 10, figs.1, 2. Original record cited.—Sowerby, Thes. Conch., vol. 3, (pt. 19), 1859, p. 90, pl. 221, fig. 5. Panama.—Tryon, Man. Conch., vol. 3, 1881, p. 218, pl. 83, fig. 521. Panama.—Dall, Proc. U. S. Nat. Mus., vol. 51, 1917, p. 578. "Lower California and the Gulf of California."

Buccinum crassum HINDS, C. B. Adams, Ann. Lyceum Nat. Hist. New York, vol. 5, 1852, p. 291. Panama.

The following is a free translation of Hinds' original Latin description:

"Shell elongate-ovate, subturrited, solid, pale brown; whorls rounded, ribbed; ribs strong, rather distant; crossed by prominent cords; outer lip strongly toothed; columella with a lamella produced directly and boldly forward."

To this can be added that there are three smooth nuclear whorls forming a rather blunt apex. This is the heaviest of the west coast species, with strong, rather coarse sculpture. The single specimen taken by the Templeton Crocker Expedition was dredged at Loc. 27567 (C. A. S.), off Oaxaca, Mexico. A specimen in the collection of the junior author was collected at Panama. Dall gave the range as Lower California and Gulf of California, but it is doubtful if it occurs in the Gulf.

Phos fusoides (C. B. Adams)

Triton fusoides C. B. ADAMS, Ann. Lyceum Nat. Hist. New York, vol. 5, 1852, p. 340. "Taboga," Panama.—Carpenter, Proc. Zool. Soc. London, 1863, p. 347.—Tryon, Man. Conch., vol. 3, 1881, p. 220.

Phos fusoides (C. B. ADAMS), Pilsbry & Lowe, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 116. "Dredged at 20 fathoms at Taboga Island."

Adams described this species as follows:

"Shell ovate-fusiform, slender; whitish, stained with brown, with a white spiral stripe near the middle of the whorls; with prominent narrow not approximate ribs, about nine on each whorl, crossed by numerous raised fine spiral lines, of which the alternate ones are mostly larger; apex acute; spire conic; whorls eight, convex, with a well impressed suture; aperture long subovate; canal short.

"Mean divergence about 35°; length .76 inch; breadth .28 inch."

A single specimen dredged in 20 fathoms at Taboga Island, Panama, by the junior author was compared with Adams' single type specimen. The nucleus is lost in both and both are dead, rather worn shells. Pilsbry and Lowe stated that it "is undoubtedly a *Phos*, in the same group as *P. gaudens* Hinds, from which it differs in weaker sculpture and greater number of axial ribs."

Phos gaudens Hinds

Plate 22, figures 1, 5

Phos gaudens Hinds, Zool. Voy. *Sulphur*, vol. 2, Moll. pt. 2, October 1844, p. 38, pl. 10, figs. 5 and 6. "Gulf of Tehuantepec, west coast of Mexico. Dredged from thirteen fathoms."—Sowerby, Thes. Conch., vol. 3, (pt. 19), 1859, p. 92, pl. 222, figs. 30, 31. Original record cited.—Tryon, Man. Conch., vol. 3, 1881, p. 218, pl. 83, fig. 518; pl. 84, fig. 527. "Gulf of Tehuantepec, W. Coast of Mexico; W. Columbia."—Tomlin, Jour. Conch., vol. 18, no. 6, 1927, p. 160. Dredged off Gorgona Island, Panama.—Pilsbry & Lowe, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, 1932, p. 116. "Montijo Bay," Panama.—Strong, Hanna & Hertlein, Proc. Calif. Acad. Sci., ser. 4, vol. 21, no. 10, 1933, p. 119. Acapulco, Guerrero, Mexico.

Phos mexicanus Dall, Proc. U. S. Nat. Mus., vol. 51, 1917, p. 578. "(Cat. No. 212111 U. S. N. M.) Ranges from Cape St. Lucas to Panama."—Zetek, Rev. Nueva, nos. 1 & 2, 1918, p. 22. Panama.—Woodring, Carnegie Inst. Washington Publ. 385, 1928, p. 260 (foot-note).—Pilsbry & Lowe, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, 1932, p. 116. "Dredged at 20 fathoms. Guaymas; Mazatlan; Manzanillo; Acapulco."

Not *Phos mexicanus* Böse, Inst. Geol. Mexico, Bol. 22, 1906, p. 38, pl. 4, figs. 18-21. "División Tuxtepec, Plioceno.—Paso Real cerca de Tuxtepec Oax[aca]."

Mangilia? dejanira Dall, Proc. U. S. Nat. Mus., vol. 56, 1919, p. 72, pl. 20, fig. 12. "Dredged in Santa Maria Bay, Lower California; Dr. Paul Bartsch."

Specimens of this species were dredged by the Templeton Crocker Expedition at the following localities:

Loc. 27588 (C. A. S.), Lat. 24° 14′ to 18′ N., Long. 111° 28′ to 29′ W. About 13 miles southeast of Cape Tosco, Sta. Margarita Island, off the west coast of Lower California, Mexico.

Loc. 27849 (C. A. S.), Lat. 23° 12′ N., Long. 106° 29′ W. Dredged in 12 fathoms off Cape San Lucas, Lower California, Mexico.

Loc. 27581 (C. A. S.), between Isabel Island and Mazatlan, Sinaloa, Mexico.

Loc. 27580 (C. A. S.), dredged about one-half mile east of Isabel Island, between Isabel Island and Mazatlan, Sinaloa, Mexico.

Loc. 27583 (C. A. S.), Lat. 22° 44′ N., Long. 105° 59′ W. Dredged in 10-17 fathoms, about 38 miles southeast of Mazatlan about 8 miles off shore.

Loc. 27574 (C. A. S.), Lat 18° 33′ N., Long. 103° 45′ W. Dredged near Manzanillo, Colima, Mexico, in 52 fathoms.

Loc. 27573 (C. A. S.), Lat. 18° 14′ N., Long. 103° 23′ W. Just off shore at Maruata, Mexico, and about 1¾ miles southeast of Pt. Telmo, Mexico, in 60 fathoms.

Loc. 27571 (C. A. S.), Lat. 16° 39′ N., Long. 99° 24′ 30″ W. to Lat. 16° 38′ N., Long. 99° 27′ 30″ W. Dredged in 20-45 fathoms, about 33 miles slightly east of Acapulco, Guerrero, Mexico, about 32 miles west of Dulce Bay.

Loc. 27527 (C. A. S.), Acapulco Bay, Guerrero, Mexico.

Loc. 27567 (C. A. S.), dredged in the Gulf of Tehuantepec, between Acapulco and Pt. Angeles, Oaxaca, Mexico.

The junior author secured specimens of the species at the following localities:

San Felipe, east coast of Lower California, Mexico.
Off Punta Peñasco, Sonora, Mexico, in 10 fathoms.
Concepción Bay, east coast of Lower California, Mexico, in 15 fathoms.
Off Guaymas, Sonora, Mexico, in 20 fathoms.
Off Mazatlan, Sinaloa, Mexico, in 20 fathoms.
Off Acapulco, Guerrero, Mexico, in 15 fathoms.
Montijo Bay, Panama, in 15 fathoms.

The following is a free translation of Hinds' original Latin description:

"Shell elongate-ovate, pointed, shining, pale, with dark brown bands near the suture; whorls rounded, ribbed, ribs about 9 at the periphery, with white nodes, interspaces finely striated, toward the base banded; aperture elongate-ovate."

To this can be added that there are four, smooth, glassy nuclear whorls and that the outer lip is nearly smooth. Dall compared *P. mexicanus* with *P. articulatus* Hinds but the latter has more numerous axial ribs and quite different nuclear whorls. In the description of *Mangilia dejanira*, Dall questioned if it belonged in the genus *Mangilia* as there was no anal fasciole. The type is a young specimen of this species.

Phos minusculus Dall

Plate 22, figure 4

Phos minusculus DALL, Proc. U. S. Nat. Mus., vol. 51, 1917, p. 578. "Dredged

in Panama Bay in 26 to 47 fathoms."—Zetek, Rev. Nueva, nos. 1 & 2, 1918, p. 22. Panama.

Dall's description of this species is as follows:

"Shell very small and thin, with about six whorls without the nucleus; whorls rounded, sutures distinct, with two undulated spiral threads in front of it, and in front of these six flattened threads with wider channeled interspaces between the sutures on the penultimate whorl; these are not swollen where they cross the ribs, of which on the last whorl there are 14, with wider interspaces; there are no intercalary spirals; outer lip slightly varicose, with about 10 internal lines; labium smooth, with no subsutural callus and no anterior keel on the pillar. Length, 12; diameter, 5; length of last whorl, 8 mm."

No specimens referable to this species were secured by the Templeton Crocker Expedition. The junior author dredged four specimens in Concepción Bay, Gulf of California, in 15 fathoms. They were compared with the type from Panama and were found to be identical. The nucleus consists of four, smooth, glassy whorls.

According to Dall this is the smallest species of this genus, so far as known.

Phos veraguensis Hinds

Plate 22, figures 2, 8, 9

Phos veraguensis HINDS, Ann. & Mag. Nat. Hist., new ser., vol. 11, April 1843, p. 257. "Pueblo Nueva, coast of Veragua; dredged in some numbers from 26 fathoms, mud."—Hinds, Zool. Voy. *Sulphur,* vol. 2, Moll. pt. 2, October 1844, p. 37, pl. 10, figs. 13, 14. Original record cited.—Sowerby, Thes. Conch., vol. 3, (pt. 19), 1859, p. 92, pl. 222, fig. 41. Original record cited.—Tryon, Man. Conch., vol. 3, 1881, p. 219, pl. 84, fig. 529. Veragua, W. Coast of Central America. [The records "West Indies; Senegal" refer to West Indian species.]—Tomlin, Jour. Conch., vol. 18, no. 6, 1927, p. 160. Coiba Island, Panama.—Strong, Hanna & Hertlein, Proc. Calif. Acad. Sci., ser. 4, vol. 21, no. 10, 1933, p. 119. Acapulco, Guerrero, Mexico.

Phos biplicatus CARPENTER, Proc. Zool. Soc. London, 1856, p. 166. Panama.—Tryon, Man. Conch., vol. 3, 1881, p. 220.

F[usinus]. porticus DALL, Nautilus, vol. 29, no. 5, Sept. 1915, p. 56. "It is an inhabitant of Panama."

Phos alternatus DALL, Proc. U. S. Nat. Mus., vol. 51, 1917, p. 578. "From the Gulf of California." (Cat. no. 212110, U. S. N. M.)

Specimens of this species were dredged by the Templeton Crocker Expedition at the following localities:

Loc. 27585 (C. A. S.), Lat. 23° 02′ N., Long. 100° 32′ W. A few miles off Gorda Point, in San José del Cabo Bay, Lower California, Mexico, in 25 fathoms.

Loc. 27584 (C. A. S.), Lat. 23° 03′ to 23° 06′ N., Long. 109° 36′ to

109° 31′ W. About 10 miles due east of San José del Cabo, Lower California, Mexico, in 20 to 220 fathoms.

Loc. 27574 (C. A. S.), Lat. 18° 33′ N., Long. 103° 45′ W. Near Manzanillo, Colima, Mexico. Just off shore at Black Head (Pta. San Juan de Lima) and about 20 miles northwest of Pt. Telmo, in 52 fathoms.

Loc. 27572 (C. A. S.), a few miles south of Acapulco Bay, Guerrero, Mexico, in 15-20 fathoms.

Loc. 37573 (C. A. S.), Lat. 18° 14′ N., Long. 103° 23′ W. Just off shore near Maruata, Mexico, and about 1¾ miles southeast of Pt. Telmo, Mexico, in 60 fathoms.

Loc. 27571 (C. A. S.), Lat. 16° 39′ N., Long. 99° 24′ 30″ W., to Lat. 16° 38′ N., Long. 99° 27′ 30″ W. About 33 miles slightly east of Acapulco, Guerrero, Mexico, and about 32 miles west of Dulce Bay, in 20-45 fathoms.

Loc. 27527 (C. A. S.), dredged in Acapulco Bay, Guerrero, Mexico.

Loc. 27558 (C. A. S.), between Punta Arenas and Bat Island, about 5 to 6 miles off Delmas, Costa Rica, in 50-60 fathoms.

The junior author secured specimens of the species at the following localities:

Punta Libertad, Sonora, Mexico.

Off Angel de la Guardia Island in the Gulf of California, Mexico, in 20 fathoms.

Off Carmen Island in the Gulf of California, Mexico, in 20 fathoms.

Off Acapulco, Guerrero, Mexico, in 20 fathoms.

The following is a free translation of Hinds' original Latin description:

"Shell elongate-ovate, cancellated, brown; whorls somewhat rounded, obsoletely banded; transversely cancellated, subnodose at the intersections; outer lip crenulated; columella smooth or slightly calloused."

To this can be added that there are three nuclear whorls of which the first two are smooth and the last has a very fine spiral thread, also that the columella has two sharp basal folds. Specimens have been compared with both Dall's and Hinds' types. The latter are said to have been acid-treated and so have lost the fine details of sculpture. The large series of specimens examined shows considerable variation in these details. *Phos biplicatus* Carpenter is unfigured and Tryon stated that "the diagnosis applies fairly well to *Phos veraguensis* Hinds." The principal difference in the description seems to be that the basal fold of the columella, not mentioned by Hinds, is slightly bifid. In the description of *Fusinus porticus* Dall it is stated that the type may perhaps not prove to be a *Fusinus*. It is undoubtedly a young specimen of this species.

Powys[6] described a *Nassa pallida* from Panama. Reeve[7] figured the shell and Tomlin[8] stated that it is now recognized as being a *Phos*. Sowerby[9] also figured

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[6] L. W. POWYS, Proc. Zool. Soc. London, 1835, p. 96.
[7] L. A. REEVE, Conch. Icon., vol. 8, *Nassa*, 1853, pl. 9, fig. 60.
[8] J. R. LE B. TOMLIN, Proc. Mal. Soc. London, vol. 20, pt. 2, 1932, p. 95.
[9] G. B. SOWERBY, Thes. Conch., vol. 3, 1859, p. 94, pl. 222, figs. 19-21.

a shell under this name but gave the locality as the Philippines. Tryon[10] copied both figures and gave both localities. He included under it *P. notatus* Sowerby, described from the Philippines.

Faustino[11] in his catalog of the marine mollusks of the Philippine Islands has cited *Phos pallidus* (Powys) from the Philippine Islands and in the synonymy of that species he included *Phos notatus*. It seems probable that the locality given by Powys was an error and that it is a Philippine shell.

Reeve[12] figured a *Phos cumingii* without description or locality. Sowerby[13] copied the figure and gave the locality as western Columbia. Tryon [14] included the species with others under *Phos gaudens* Hinds. The figure is poor, but resembles some of the west coast species in the genus *Strombina* more than those in the genus *Phos*.

The genus *Phos* is very poorly represented in the literature of the Tertiary of Western North America.[15] *"Phos?" martini* Dickerson,[16] of the Eocene of Marysville Buttes, is probably not a *Phos*. *Phos blakianus* Anderson & Hanna,[17] described from the type Tejon Eocene near Grapevine Creek, Kern County, California, is said to be an *Endopachychilus* Cossmann.[18] *Phos dumbleana* Anderson,[19] of the Miocene of Kern River, California, may be a *Phos* as stated by Hanna[20] but *"Nassa" chehalisensis* Weaver[21] from the Miocene of western Washington, considered by Etherington,[22] to be a variety of *"Tritiaria* (*Antillophos*) *dumblei,"* appears closer to *Nassarius* of the *N. perpinguis* group than to the genus *Phos*. *Phos cocosensis* Dall has been recorded as a Pleistocene fossil from Albemarle Island of the Galapagos group.[23]

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10 G. W. TRYON, JR., Man. Conch., vol. 3, 1881, p. 218, pl. 83, figs. 494, 496.

11 L. A. FAUSTINO, Bureau of Science, Manila, Philippine Islands, Monograph 25, 1928, p. 242.

12 L. REEVE, Elem. Conch., vol. 1, 1860, p. 67, pl. 3, fig. 16.

13 G. B. SOWERBY, Thes. Conch., vol. 3, 1859, p. 91, pl. 222, fig. 38.

14 G. W. TRYON, JR., Man. Conch., vol. 3, 1881, p. 218, pl. 83, fig. 519.

15 *Phos mexicanus* Böse, Inst. Geol. Mexico, Bol. Nr. 22, 1906, p. 38, pl. 4, figs, 18-21. This species reported in the Tuxtepec division of the Pliocene of Oaxaca, belongs to the Caribbean province, not to the Pacific.

16 R. E. DICKERSON, Univ. Calif. Publ. Bull. Dept. Geol., vol. 7, no. 12, 1913, p. 288, pl. 13, fig. 5.

17 F. M. ANDERSON and G. D. HANNA, Calif. Acad. Sci., Occas. Papers, vol. 11, 1925, p. 73, pl. 8, fig. 16, pl. 11, figs. 8, 9.

18 R. B. STEWART, Proc. Acad. Nat. Sci. Philadelphia, vol. 78, 1927, pp. 302, 391.

19 *Pleurotoma* (*Clathurella*)*dumblei* Anderson, Proc. Calif. Acad. Sci., ser. 3, (Geol.), vol. 2, no. 2, 1905, p. 204, pl. 15, figs. 60, 61; not Harris, 1895. Renamed *Phos dumbleana* by Anderson in Hanna, Proc. Calif. Acad. Sci., ser. 4, vol. 13, no. 10, 1924, p. 183.

20 G. D. HANNA, Proc. Calif. Acad. Sci., ser. 4, vol. 13, no. 10, 1924, p. 183.

21 C. E. WEAVER, Univ. Wash. Publ. Geol., vol. 1, no. 1, 1916, p. 46, pl. 5, figs. 69, 70.

22 T. J. ETHERINGTON, Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 20, no. 5, 1931, p. 100, pl. 12, figs. 6, 21, 22.

23 W. H. DALL and W. H. OCHSNER, Proc. Calif. Acad. Sci., ser. 4, vol. 17, no. 4, 1928, p. 96, pl. 2. fig. 14.

EXPLANATION OF PLATE

PLATE 22

Fig. 1. *Phos gaudens* Hinds. This is a figure of the type specimen of *Phos mexicanus* Dall (Proc. U. S. Nat. Mus., vol. 51, 1917, p. 578, Cat. No. 212111, U. S. N. M.), from U. S. Bureau of Fisheries Station 3034, off Point Fermin, Lower California, Mexico, dredged in 24 fathoms. Length 23 mm., diameter 8.5 mm., length of last whorl 13 mm. This is not *Phos mexicanus* Böse. (p. 312)

Fig. 2. *Phos veraguensis* Hinds. This is a figure of the type specimen of *Phos alternatus* Dall (Proc. U. S. Nat. Mus., vol. 51, 1917, p. 578, Cat. No. 212110, U. S. N. M.), from U. S. Bureau of Fisheries Station 3037, off Guaymas, Sonora, Mexico, dredged in 20 fathoms. Length 26 mm., width 12 mm. (p. 314)

Fig. 3. *Phos chelonia* Dall. This is a figure of the type specimen of *Phos chelonia* Dall (Proc. U. S. Nat. Mus., vol. 51, 1917, p. 578, Cat. No. 194961, U. S. N. M.), from U. S. Bureau of Fisheries Station 2813, Galapagos Islands, in 40 fathoms. (p. 310)

Fig. 4. *Phos minusculus* Dall. (Proc. U. S. Nat. Mus., vol. 51, 1917, p. 578, Cat. No. 122775, U. S. N. M.), from U. S. Bureau of Fisheries Station 2804, dredged in Panama Bay, in 47 fathoms. Length 12 mm., diameter 5 mm., length of last whorl 8 mm. (p. 313)

Fig. 5. *Phos gaudens* Hinds. Plesiotype, No. 6997 (Calif. Acad. Sci. Paleo. type coll.), from Loc. 27581 (C. A. S.), dredged between Santa Isabel Island and Mazatlan, Sinaloa, Mexico; Templeton Crocker Expedition. Length 24.5 mm., diameter 9 mm., length of last whorl, approximately 10.4 mm. (p. 312)

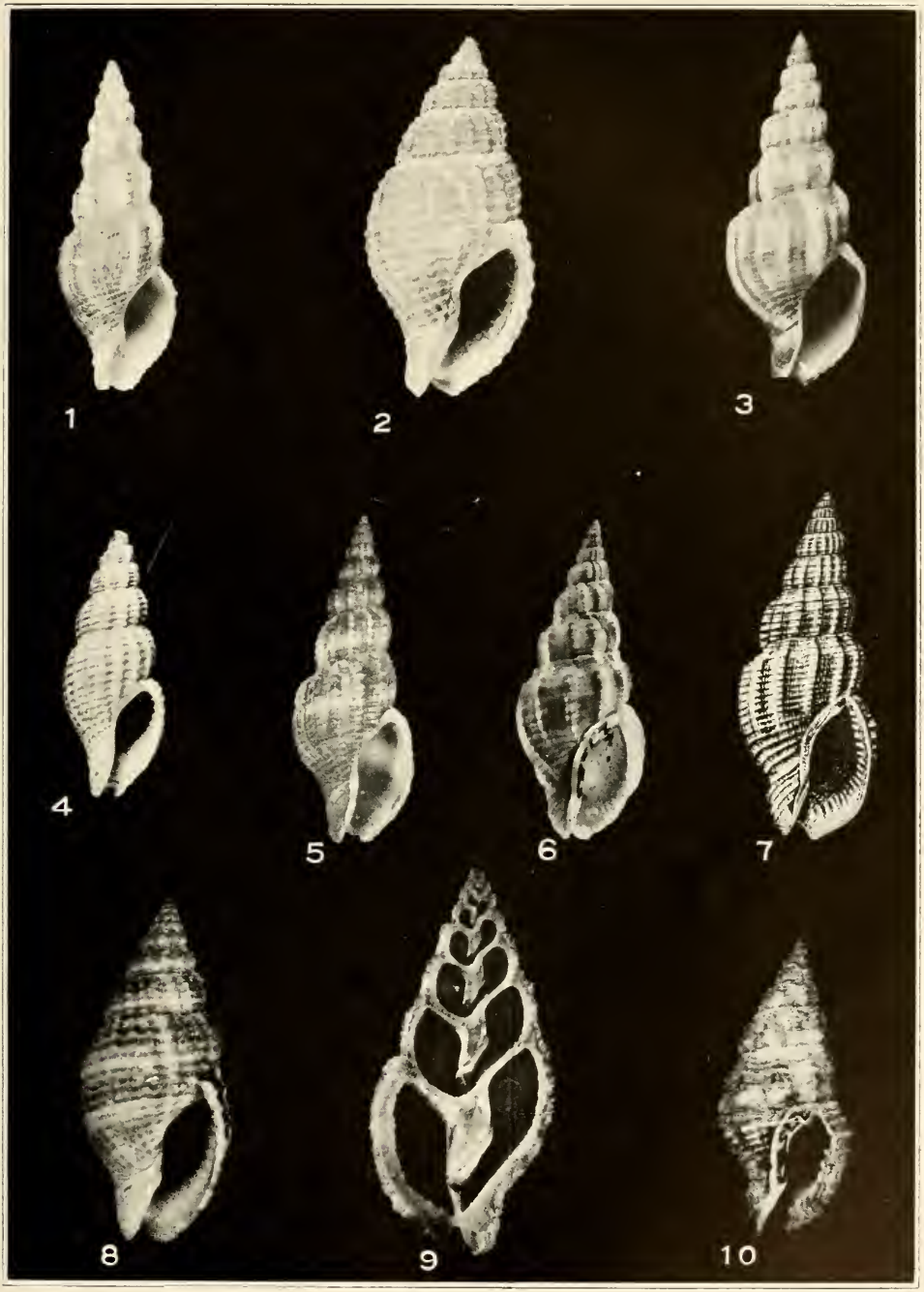
Fig. 6. *Phos articulatus* Hinds. Plesiotype, No. 6998 (Calif. Acad. Sci. Paleo. type coll.), from Loc. 27585 (C. A. S.), Lat. 23° 02′ N., Long. 109° 32′ W., dredged in 25 fathoms, a few miles off Gorda Point in San José del Cabo Bay, Lower California, Mexico; Templeton Crocker Expedition. Length 46.1 mm., diameter 18.9 mm., length of last whorl, 21 mm. (p. 309)

Fig. 7. *Phos cocosensis* Dall. A reproduction of the figure of the type given by Dall (Bull. Mus. Comp. Zoöl., vol. 43, no. 6, 1908, pl. 8, fig. 5), from U. S. S. "*Albatross*," station 3368, near Cocos Island, Gulf of Panama, in 66 fathoms. Length 47 mm., diameter 19 mm., length of last whorl, 28 mm. (p. 310)

Fig. 8. *Phos veraguensis* Hinds. Plesiotype, No. 6999 (Calif. Acad. Sci. Paleo. type coll.), from Loc. 27584 (C. A. S.), Lat. 23° 03′ to 23° 06′ N., Long. 109° 36′ to 109° 31′ W., in 20 to 220 fathoms. About 10 miles due east of San José del Cabo, Lower California, Mexico; Templeton Crocker Expedition. Length 24.8 mm., diameter 11.7 mm., length of last whorl 13 mm. (p. 314)

Fig. 9. *Phos veraguensis* Hinds. Plesiotype, No. 7000 (Calif. Acad. Sci. Paleo. type coll.), from the same locality as the specimen shown in figure 8. Length 28.3 mm., diameter 12.8 mm., length of last whorl 15.3 mm. This figure shows an axial section of the interior of the shell and reveals the presence of two small plates on the columella. (p. 314)

Fig. 10. *Phos crassus* Hinds. Plesiotype, No. 7001 (Calif. Acad. Sci. Paleo. type coll.), from Loc. 27567 (C. A. S.), dredged off the coast of Oaxaca, Mexico, in the Gulf of Tehuantepec; Templeton Crocker Expedition. Length 41 mm., diameter 19 mm., length of last whorl 21 mm. (p. 311)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TRANSACTIONS

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A FURTHER REPORT ON BIRDS FROM SONORA, MEXICO, WITH DESCRIPTIONS OF TWO NEW RACES

BY

A. J. VAN ROSSEM AND THE MARQUESS HACHISUKA

Dickey Collections, California Institute of Technology

SAN DIEGO, CALIFORNIA

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A FURTHER REPORT ON BIRDS FROM SONORA, MEXICO, WITH DESCRIPTIONS OF TWO NEW RACES

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Dickey Collections, California Institute of Technology

Some years ago (Trans. San Diego Soc. Nat. Hist., 6, No. 19, April 30, 1931), van Rossem published a list of Sonora land birds based in part on specimens in the Dickey collection, in part on specimens in the collection of the San Diego Society of Natural History, and in part on still others from private collections. A further report, particularly relating to water birds, is now desirable.

In the interim since 1931, the San Diego Society of Natural History has acquired from several sources a considerable amount of Sonora material, including a large donation of Sonora bird skins from Mr. Griffing Bancroft. The San Diego Society of Natural History specimens recorded in these notes were in almost every instance taken by Mr. Bancroft or his assistants. Additional material (either as specimens or notes) used in the preparation of this paper has also very kindly been placed at our disposal by Mr. A. W. Anthony, Dr. Louis B. Bishop, Mrs. Donald Dickey, Mr. Chester Lamb, Mr. J. T. Wright, the Museum of Vertebrate Zoology, the Museum of Comparative Zoölogy and the University of Michigan.

Specimens are in the Dickey collection unless otherwise noted. Observations, unless otherwise credited, are by van Rossem.

Gavia arctica pacifica (Lawrence)

The Pacific Loon was noted as a common spring migrant off San Estéban Island between April 17 and 20, 1930.

Colymbus dominicus bangsi subsp. nov.

Type.—Female adult, no. 218269, Museum of Comparative Zoölogy; Santiago, Lower California, Mexico, November 15, 1887; collected by M. Abbott Frazar.

Subspecific characters.—Resembles *Colymbus dominicus brachypterus* Chapman of southern Texas and Middle America, but, sex for sex, bills definitely smaller; upper parts (including pileum) slightly grayer and paler; breeding plumage darker below, with spotting more prominent.

Range.—Arid Tropical Zone of Lower California, southern Sonora, and

probably other portions of northwestern Mexico.

Remarks.—Nearly ten years ago van Rossem noticed the small bills and dark summer coloration of the Lower California least grebes. At the time he talked the matter over with the late Outram Bangs, but there were certain points of disagreement and van Rossem naturally deferred to Bangs. Later Bangs wrote that he was convinced, after a careful restudy of the question, that the Lower California colony belonged to a perfectly distinct race. Chester Lamb (in 1933) collected a specimen at Agiabampo on the coast of extreme southern Sonora, and very kindly allowed van Rossem to examine it. Since the bird was in breeding plumage it would seem, taken in connection with the date (April 21), that the race *bangsi* is also a breeding bird of Sonora.

On various occasions, ornithologists have expressed curiosity concerning the systematic status of the least grebes of Central America. With a fair amount of material, it may be stated that such El Salvador specimens as van Rossem has seen belong apparently with *brachypterus*. This is shown by the following measurements:

brachypterus	WING	EXPOSED CULMEN
6 ♂ from Texas	88 - 93	22.7 - 24.0
5 ♂ from El Salvador	88 - 92	22.2 - 24.1
bangsi		
8 ♂ from Lower Calif.	85 - 88	20.0 - 21.2
brachypterus		
3 ♀ from Texas	90 - 92	22.5 - 23.6
6 ♀ from El Salvador (2 immature)	83 - 91	19.2 - 20.2
bangsi		
6 ♀ from Lower Calif.	83 - 88	16.0 - 18.8

Colymbus nigricollis californicus (Heermann)

Observed as follows: San Estéban Island, April 17, 1930, common; Tiburón Island, April 19, 1925, abundant; San Pedro Martír Island, April 20, 1930, common; San Pedro Nolasco Island, April 21, 1930, common; Guaymas Harbor, April 21 to 25, 1930, common.

At these dates most of the birds were in breeding plumage and were thus readily identifiable. Large rafts of scores, or even hundreds, were frequently observed on the open sea.

Aechmophorus occidentalis (Lawrence)

Price, under circumstances none too certain, has previously recorded the Western Grebe from the mouth of the Colorado River in winter. In the Thayer collection at the Museum of Comparative Zoölogy, is a specimen taken by W. W. Brown, Jr., at "Precidio" [= Guaymas] on March 27, 1905.

Puffinus griseus (Gmelin)

Two individuals were seen (unmistakably) 5 miles west of Tiburón Island on April 25, 1925.

Oceanodroma melania melania (Bonaparte)

Seen in considerable numbers off San Estéban Island on April 21, and off the entrance to Guaymas Harbor on April 27, 1930.

Halocyptena microsoma Coues

Observed as extremely common off San Estéban Island, April 17, 1930; off Tiburón Island, April 19, 1925; off Guaymas Harbor, April 21, 1930. At these dates it was obvious that both this species and *melania* were at the height of their migrations. Great rafts of up to several hundred individuals were frequently seen sitting on the open water.

Phaethon aethereus mesonauta Peters

The Red-billed Tropic-bird has been recorded at practically all times of the year from many Gulf points. However, it was interesting to observe it at the mouth of the Colorado River on April 25, 1925.

Although there seems to be in some quarters a reluctance to recognize *mesonauta*, it appears to be a good race—at least so far as one can judge by the characters shown by Gulf specimens.

Pelecanus erythrorhynchos Gmelin

Ten individuals, none of which showed the bill knob which is indicative of breeding activity, were seen on an estero in Guaymas Harbor on April 22, 1930.

Phalacrocorax auritus albociliatus Ridgway

In addition to published data (Tiburón Island; Punta Peñascosa; mouth of the Colorado), there are additional records to show the Farallon Cormorant to be a common species in the Gulf, although there appear to be no actual breeding records. Lamb (MS) noted it as common at Guaymas on January 3, 1933; Brown (Mus. Comp. Zoöl.) took a specimen there on March 23, 1905; and van Rossem found it commonly at San Pedro Martír Island on April 18, 1925.

Phalacrocorax penicillatus (Brandt)

Brandt's Cormorant was noted as follows: San Pedro Martír Island, April 18, 1925, where nesting commonly; San Estéban Island, April 17, 1930, abundant off shore; San Pedro Nolasco Island, April 21, 1930; off Guaymas, April 30, 1930, common.

Fregata magnificens rothschildi Mathews

A specimen from Guaymas, June 14, 1930, and another from Lobos Island, May 28, 1930 (S. D. S. N. H.), are certainly of the species *magnificens*. We follow Swarth in recognizing the race *rothschildi*, but doubt that it will bear investigation when adequate material is assembled.

Ardea herodias treganzai Court

The Great Basin race of the great blue heron has been reported frequently

as occurring south to Guaymas, but actual specimens to verify these ascriptions have been conspicuous by their absence. Additional sight records are: Guaymas, January 3 and 6, 1933 (Lamb); and San Pedro Nolasco Island, April 21, 1930. Specimens (S. D. S. N. H.) taken six miles north of Guaymas, June 15, 1928, and at Tóbari Bay, April 28, 1930, are definitely of the race *treganzai*. Both were breeding birds.

Butorides virescens anthonyi (Mearns)

J. T. Wright took a migrant *anthonyi* at Tecoripa on March 1, 1929, and a juvenile, still in partial down, at Saric on August 15, 1929. Pierce Brodkorb informs me that in the University of Michigan collections is a skin of this race collected by Berry Campbell at Pilares in northeastern Sonora on July 27, 1935. These records, combined with others previously published, appear to establish *anthonyi* as rather common in northern Sonora.

Butorides virescens virescens (Linnaeus)

The most careful scrutiny fails to reveal any characters by which to distinguish the breeding green herons of the Arid Tropical Zone of Sonora from *virescens* of the eastern United States. Oberholser (Proc. U. S. Nat. Mus., 42, 1912, 533) has shown that *virescens* occurs north on the Pacific coast of Mexico as far as Mazatlan. The presence of this race in southern Sonora is, while interesting, not particularly remarkable, save that it would seem to indicate that *frazari* of Lower California is of southern, rather than of northern, origin.

Specimens of *virescens*, all of which were breeding when collected, have been examined from Tóbari Bay (2), April 27 and June 12, 1930; Lobos Island, (1), May 25, 1930; Kino Bay, (1), May 16, 1930. All except the first listed are in the collection of the San Diego Society of Natural History.

Florida caerulea caerulescens (Latham)

Six specimens in the collection of the San Diego Society of Natural History are the dark colored tropical race. They were collected at Lobos Island (2), May 30, 1930; and at Tóbari Bay (4), June 12, 1930.

Dichromanassa rufescens dickeyi van Rossem

Lamb noted one at Guaymas on January 3, 1933; the Museum of Comparative Zoölogy contains a specimen taken by Brown in the same locality on March 19, 1905; and in the collection of the San Diego Society of Natural History are two taken at Tóbari Bay on April 28, 1930. These three examples are typical *dickeyi*.

Casmerodius albus egretta (Gmelin)

Records additional to those already published are that American Egrets were noted as common at Guaymas in late April and early May, 1930; and as breeding commonly at Tóbari Bay from April 26 to May 1, 1930.

Leucophoyx thula brewsteri (Thayer and Bangs)

Lamb noted a Snowy Egret at Guaymas on January 3, 1933. A skin from

Lobos Island (S. D. S. N. H.) taken May 25, 1930, is just about intermediate in characters between *brewsteri* and *thula*. In the absence of further material this bird is referred to *brewsteri*, in keeping with the determinations of Thayer and Bangs, Bent, and others who have examined Sonora specimens.

Hydranassa tricolor ruficollis (Gosse)

Two specimens, collected at Tóbari Bay on April 27 and 29, 1930, are in the collection of the San Diego Society of Natural History.

Nycticorax nycticorax hoactli (Gmelin)

Black-crowned Night Herons were noted by Lamb at Guaymas on January 6, 1933; and the collection of the San Diego Society of Natural History contains a (presumably) breeding specimen taken in that locality on June 22, 1928. The species was noted as common at Tóbari Bay between April 26 and May 1, 1930.

Nyctanassa violacea bancrofti Huey

A specimen (S. D. S. N. H.) taken at Tóbari Bay on April 28, 1930, seems to be exactly like Lower California examples of this race.

Heterocnus cabanisi (Heine)

The Dickey collection contains a specimen taken by Wright at Tésia on March 17, 1930. Wright states that the Tiger Bittern is fairly common and breeds in the Mayo River Valley. Van Rossem found no trace of it anywhere along the coast. The single skin seems to be identical with El Salvador specimens of similar age.

Botaurus lentiginosus (Montagu)

Wright took a Bittern at El Doctor on January 25, 1929.

Mycteria americana Linnaeus

The Wood Ibis was found to be commonly and generally distributed all along the coast from Guaymas southward to Tóbari Bay in April and early May, 1930. In the collection of the San Diego Society of Natural History is a specimen taken six miles north of Guaymas on June 15, 1928.

Guara alba (Linnaeus)

Three specimens in the collection of the San Diego Society of Natural History were taken, respectively, at Tóbari Bay on April 28 and June 12, 1930, and at Guásimas Lagoon on May 12, 1930. The White Ibis was noted as common in the first named locality from April 26 to May 1, 1930.

Ajaia ajaja (Linnaeus)

Wright states that Spoonbills are common in the Mayo River Valley. Van Rossem found them common at Tóbari Bay between April 26 and May 1, 1930, and saw several at Guaymas on May 5 of the same year. Three specimens taken,

respectively, at Tóbari Bay, April 28 and May 1, and at Kino Bay, May 16, 1930, (S. D. S. N. H.) are all in breeding plumage. However, the largest ova in the Tóbari Bay females were only about 3 mm. in diameter and the birds were obviously not nearly ready to breed.

Chen hyperborea (Pallas)

Donald Dickey collected two specimens at San Luis on December 9, 1925, and Wright took another at El Doctor on February 7, 1929. Both localities are in the Colorado River Delta.

Dendrocygna bicolor helva Wetmore and Peters

A flock of at least 100 Fulvous Tree-ducks was seen on an exposed tide flat in Guaymas Harbor on May 5, 1930.

Querquedula cyanoptera (Vieillot)

A small flock of seven or eight Cinnamon Teal was seen just south of Nogales on December 21, 1931. The Dickey collection contains two specimens taken by Wright at El Doctor, January 27, and Saric, September 14, 1929.

Nettion crecca carolinense (Gmelin)

El Doctor (January 20 and 24, 1929); Saric (August 17, 1929); and Chinobampo (February 8, 1930) are localities and dates which supplement the few previously published records.

Dafila acuta tzitzihoa (Vieillot)

Two specimens were taken by Wright at El Doctor on January 21, 1929. There are only two previously published records, both from the northern part of the State. The apparent scarcity of the Pintail in Sonora is surprising. Van Rossem did not meet it anywhere along the coast in the winter of 1931-32, although ducks of several species were abundant there.

Mareca americana (Gmelin)

Lamb noted the Baldpate at San José de Guaymas on January 6, 1933. The Museum of Comparative Zoölogy contains two specimens taken by Brown at Aranjuez [= San José de Guaymas] on March 22, 1905.

Spatula clypeata (Linnaeus)

In the Museum of Comparative Zoölogy is a specimen taken by Brown at "Precidio" [= Guaymas] on March 25, 1905. Wright found the Shoveller to be a fairly common winter visitant at El Doctor in January, 1929, and took a specimen on January 27.

Nyroca americana (Eyton)

A specimen in the Museum of Comparative Zoölogy, taken by Brown at Guaymas on March 28, 1905, verifies certain sight records from the same locality.

Nyroca affinis (Eyton)

The Lesser Scaup is probably the commonest salt-water duck in the State. Lamb noted it at Guaymas on January 3, 1933, and at San José de Guaymas on January 6; Huey collected one at Kino Bay, February 23, 1935; and Brown (M. C. Z.) took two at Aranjuez on March 22, 1905. Many lesser scaups were noted at Guaymas between April 21 and 25, 1930, but it is believed that most, if not all of these birds were non-breeding individuals which would not have gone north.

Charitonetta albeola (Linnaeus)

One specimen, an adult male, was taken by Wright at Ciudad Obregón on November 17, 1930.

Melanitta perspicillata (Linnaeus)

Surf Scoters were seen in small numbers off San Estéban Island from April 17 to 19, 1930.

Erismatura jamaicensis rubida (Wilson)

A specimen in the Museum of Comparative Zoölogy, collected by Brown at Guaymas on March 10, 1905, is apparently the first and only authentic State record of the Ruddy Duck. The "Pachico, Sonora" record in the Biologia Centrali Americana is really a Chihuahua citation and dates back to Allen's ambiguously worded report on the specimens collected by the Lumholtz expedition.

Mergus merganser americanus Cassin

Lamb noted the American Merganser at San José de Guaymas on January 9, 1933. Van Rossem found it to be fairly common about San Estéban Island on April 17, 1930, and also noted a pair at Guaymas on April 22, 1930.

Mergus serrator Linnaeus

This is a very common coastwise winter duck, and there are numerous localities on record. The latest seasonal dates noted are two "Precidio" [= Guaymas] specimens in the Museum of Comparative Zoölogy, taken by Brown on March 20 and 21, 1905.

Porzana carolina (Linnaeus)

Wright took three specimens at El Doctor on January 24, 27, and 31, 1929.

Fulica americana americana Gmelin

Lamb noted Coots at San José de Guaymas on January 19, 1933; Wright took three specimens at El Doctor on January 21 and 24, 1929; Brown (M. C. Z.) collected one at "Precidio" [= Guaymas] on March 21, 1905.

Squatarola squatarola (Linnaeus)

The Black-bellied Plover was noted as a fairly common migrant at Tóbari

Bay from April 26 to May 1, 1930. At this time most of the individuals observed were in breeding plumage.

Charadrius hiaticula semipalmatus Bonaparte

A common migrating species at Tóbari Bay from April 26 to May 1, 1930.

Charadrius wilsonia beldingi (Ridgway)

Lamb collected a specimen at Agiabampo on April 18, 1933. As previously recorded by many authors, Belding's Plover is a common permanent resident the entire length of the Sonora coast.

Numenius hudsonicus Latham

A specimen taken by Brown (M. C. Z.) at "Precidio" [= Guaymas] on March 25, 1905, is apparently the only individual to have been taken, to date, in Sonora. The species was observed as migrating commonly at Tóbari Bay from April 26 to May 1, 1930.

Numenius americanus americanus Bechstein

The subspecific status of the long-billed curlews which were noted as common at Tóbari Bay from April 26 to May 1, 1930, is in doubt. However, the single example of the species taken to date (van Rossem, 1933) is of the nominate race.

Limosa fedoa (Linnaeus)

Some of the flocks which were noted at Tóbari Bay between April 26 and May 1, 1930, totaled at least 200 individuals. At this time all, or nearly all, of the godwits seen were in breeding plumage. Two specimens were collected on April 28 and 29, respectively.

Tringa flavipes (Gmelin)

Two specimens were collected by Wright at Ciudad Obregón on November 14, 1929.

Tringa melanoleuca (Gmelin)

Brown (M. C. Z.) took three at Guaymas on February 27, 1905; Lamb noted one at Hermosillo on December 22, 1932; and Wright collecetd two at Ciudad Obregón on November 14, 1929.

Tringa solitaria cinnamomea (Brewster)

Two specimens taken by Wright at Saric on September 14, 1929, are typical of the western race of the solitary sandpiper.

Actitis macularia (Linnaeus)

The University of Michigan possesses a specimen taken by Campbell at

Pilares, July 14, 1935; Wright took two at Saric on August 2 and September 18, 1929. Van Rossem noted Spotted Sandpipers as common all along the central and southern coast and off-shore islands from April 17 to May 14, 1930. Some specific localities are: San Estéban Island, San Pedro Martír Island, San Pedro Nolasco Island, Tóbari Bay, and Guaymas.

Catoptrophorus semipalmatus inornatus (Brewster)

The Western Willet, as previously has been noted, is seasonally abundant along the length of the Sonora coast. Additional records are: El Doctor from January 21 to 29 (4 specimens), 1929; Guaymas ["Precidio"], March 27 and 29, 1905; Tóbari Bay, April 20, 1930; and San Estéban Island (noted), April 17, 1930.

Heteroscelus incanus (Gmelin)

On April 21, 1930 a single Wandering Tattler was seen in company with two spotted sandpipers on the rocky shores of San Pedro Nolasco Island.

Arenaria interpres morinella (Linnaeus)

Turnstones are evidently regular spring migrants along the Sonora coast, as the following records indicate: one Lamb collection, Agiabampo, April 18, 1933; one seen at San Pedro Nolasco Island, April 21, 1930; two taken at Tóbari Bay, April 29 and May 1, 1930. In the last named locality they were fairly common and occurred as singles, pairs, and trios, usually in company with other shore birds.

Arenaria melanocephala (Vigors)

Two Black Turnstones were seen at San Estéban Island on April 17, and another pair was noted on the rocky shores of San Pedro Nolasco Island on April 21, 1930.

Limnodromus griseus scolopaceus (Say)

Wright took seven at Ciudad Obregón on November 13, 1929; the species was noted as an abundant migrant at Tóbari Bay from April 26 to May 1, 1930; and in the collection of the San Diego Society of Natural History are two (probably non-breeding) specimens taken at Tóbari Bay on June 27, 1930.

Capella gallinago delicata (Ord)

Wright took two at El Doctor on January 21 and 24, respectively, and another at Tecoripa on March 25, 1929. In the collection of the San Diego Society of Natural History are two taken 15 miles south of Nogales on February 5, 1929.

Calidris canutus rufus (Wilson)

This was the most abundant shore bird present at Tóbari Bay from April 26 to May 1, 1930. A single specimen was taken on April 28.

Crocethia alba (Pallas)

The Sanderling was found to be an abundant migrant at Tóbari Bay from April 26 to May 1, 1930.

Ereunetes mauri Cabanis

The M. C. Z. collection contains a specimen collected by Brown at Guaymas on March 26, 1905. Western Sandpipers were abundant from Guaymas to Tóbari Bay from April 22 to May 1, 1930. One flock at the last named locality contained at least 500 birds.

Erolia minutilla (Vieillot)

Wright took eight specimens at El Doctor on January 27, 1929, and in the M. C. Z. are two collected at Guaymas on February 22 and 23, 1905. The Least Sandpiper was noted as abundant from Guaymas to Tóbari Bay from April 22 to May 14, 1930.

Erolia alpina sakhalina (Vieillot)

The Red-backed Sandpiper was an abundant migrant at Tóbari Bay between April 26 and May 1, 1930. One specimen was collected on April 28.

Himantopus himantopus mexicanus (Müller)

Wright took five specimens at Ciudad Obregón on November 14, 1929. At least a dozen Stilts was observed in one flock at Tóbari Bay on April 29, 1930.

Recurvirostra americana Gmelin

Brown (M. C. Z.) took an Avocet at Guaymas on March 22 and another at Aranjuez on March 28, 1905; Wright collected one at Ciudad Obregón on November 14, 1929; and van Rossem saw a small flock of four at Tóbari Bay on April 29, 1930.

Steganopus tricolor Vieillot

Two birds were collected by Wright at Saric on September 10, 1929. Numerous flocks and individuals were seen in migration off Tiburón Island on April 19, 1925.

Lobipes lobatus (Linnaeus)

Wright collected one specimen at Saric on September 10, 1929, and this is apparently the only inland record for the State. Northern Phalaropes were seen at sea in immense numbers off San Estéban Island on April 17, and off Tiburón Island on April 19, 1930.

Larus delawarensis Ord

The Ring-billed Gull was noted by Lamb at Guaymas on January 3, 1933; Brown (M. C. Z.) took a specimen in the same locality on March 23, 1905; van Rossem noted the species as common there between April 22 and May 14, 1930.

Larus californicus Lawrence

Noted as common off San Estéban Island, April 17 to 19, 1930, where observed drifting in large flocks in a northerly direction. California Gulls were also found to be common at Guaymas on various dates between April 21 and May 14, and at Tóbari Bay from April 26 to May 1, 1930.

Larus atricilla Linnaeus

Laughing Gulls in breeding plumage were commonly seen by van Rossem at Guaymas from April 22 to May 14, 1930, at which latter date he left the locality. At Tóbari Bay, from April 26 to May 1, 1930, they were even more common and, more often than otherwise, were in pairs. Two specimens collected at Tóbari Bay were in breeding condition, and the actions of many pairs observed strongly indicated that they were either breeding or about to do so. The number of laughing gulls in spring and early summer on the coast of central and southern Sonora makes more understandable the occurrence of occasional breeding pairs on Salton Sea in southern California.

Larus philadelphia (Ord)

Brown (M. C. Z.) took specimens at Guaymas ["Precidio"] on March 23 and 29, 1905; Lamb noted the species in the same locality on January 22, 1933, and van Rossem also observed it there in considerable numbers from April 22 to May 4, 1930. In the last instance, individuals were noted in every stage of plumage from one year old immatures to fully plumaged adults.

Gelochelidon nilotica vanrossemi Bancroft

Gull-billed Terns were noted as not uncommon at Tóbari Bay from April 26 to May 1, 1930. They were usually in pairs and it was the distinct impression that they were preparing to breed on one or more sand islands at the entrance to the bay. Unfortunately no specimens were taken, but there can be little doubt that they were of the same race as that which breeds on Salton Sea in southern California.

Hydroprogne caspia imperator (Coues)

One or more Caspian Terns were seen daily at Guaymas from April 21 to 23, 1930.

Sterna forsteri Nuttall

Forster's Terns were seen at the mouth of the Colorado River on April 23, 1925; at Guaymas (common) on April 21 and May 4, 1930; and at Tóbari Bay from April 26 to May 1, 1930. A specimen was collected at Guásimas Lagoon on May 12, 1930. In no instance was there any evidence of breeding, and the species was evidently purely migratory.

Sterna albifrons mexicanus subsp. nov.

Type.—Breeding male adult, no. 30,285, Dickey collection; Tóbari Bay,

Sonora, Mexico, April 29, 1930; collected by A. J. van Rossem; original number 13,000.

Subspecific characters.—Similar to *Sterna albifrons browni* Mearns of southern California and northern Lower California, but size definitely smaller; coloration darker throughout and with the underparts even more strongly suffused with pearl gray.

Range.—Coast of southern Sonora (Arid Tropical Zone) from Guaymas south to Sinaloa, and probably south along the west coast of Mexico for some distance.

Remarks.—The least terns of the Sonora coast were immediately recognized in the field as distinct from the familiar *browni* of southern California. At both Tóbari Bay and Guaymas they were either breeding or preparing to do so, but were decidedly rare and only seven specimens could be collected.

Regarding the distribution of *mexicanus*, one hesitates to suggest that all breeding least terns to the southward will be found to belong to that race. However, it would seem most improbable that *browni*, as a breeding race, reappears to the southward of *mexicanus*.

Measurements.—

	Wing	Exposed culmen
14 ♂ *browni*	167 - 177	26.7 - 28.3
4 ♂ *mexicanus*	162 - 164	24.6 - 26.0
7 ♀ *browni*	170 - 174	26.1 - 27.0
3 ♀ *mexicanus*	160 - 165	24.9 - 25.2

✓ **Thalasseus maximus maximus** (Boddaert)

Anthony noted the Royal Tern at Estrada de Tasiola on December 4, 1930. Additional records are: mouth of the Colorado River, April 22 and 23, 1925; Guaymas, April 21 to May 14, 1930; Tóbari Bay, April 26 to May 1, 1930; Lobos Island (S. D. S. N. H.), May 25, 1930. Previously published data show this tern to be a fairly common breeder from George Island southward.

✓ **Rynchops nigra oblita** Griscom

The nine Skimmers collected at Algodones Lagoon (May 1, 1930), and Guásimas Lagoon (May 12, 1930) seem satisfactorily to belong to this race which was described by Ludlow Griscom (Ibis, 1935, p. 545) on the basis of six winter specimens from the Pacific coast of Guatemala. There are slight differences to be noted between the Sonora birds and the published description, but these are probably due to season. Compared with typical *nigra*, these specimens are tinged with pale gray on the axillars and under wing-coverts, and also have more gray on the inner webs of the lateral rectrices.

Although no nests were found it was perfectly evident that the breeding season was at hand.

28,898

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PALEONTOLOGY OF THE PLEISTOCENE OF POINT LOMA, SAN DIEGO COUNTY, CALIFORNIA*

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INTRODUCTION

The study of the fossils of the Point Loma Terrace deposits was undertaken primarily to determine the ecology of the fauna. The specimens were examined, identified, and their identifications checked by specialists in Pleistocene Marine Paleontology. The work was done by the author while a graduate student in the Division of Geological Sciences of the California Institute of Technology.

LOCATION OF THE AREA

The material for study was obtained from the lowermost marine terrace on the west side of Point Loma, a promontory of considerable length which extends into the Pacific Ocean in a north-south direction, protecting San Diego Harbor on the west. The entire southern half of the peninsula is a government military and naval reservation; the northern and broader half is largely a residential district of the city of San Diego.

COLLECTIONS AND METHOD OF STUDY

The material for study was collected by Dr. W. P. Popenoe, Curator in Invertebrate Paleontology, and Mr. David Scharf, graduate

* Contribution No. 216, Balch Graduate School of the Geological Sciences, California Institute of Technology, Pasadena, California.

student, of the California Institute of Technology, on a collecting trip in 1930. A later trip for additional collecting was made in the winter of 1935-1936 by Dr. Popenoe and the writer.

The fossils were identified by the author, largely according to the nomenclature of Grant and Gale.[1] The identifications were checked by Dr. Popenoe, under whose supervision the work was conducted. Dr. U. S. Grant, Associate Professor of Geology, University of California at Los Angeles, checked the fossil list, edited the manuscript, and offered helpful suggestions. Mr. A. M. Strong, of Los Angeles, aided in the identification of the small gastropods; in addition he contributed, from his personal experience, data on the ecology of the forms.

Review of Pertinent Literature

There are few papers on the geology of the Point Loma area. No thorough geologic study has ever been published, although Messrs. U. S. Grant and L. G. Hertlein are now preparing a systematic study of the region. The only geologic report of significance is that of Ellis and Lee,[2] which contains a generalized geological map of Point Loma, indicating the distribution of the marine terrace deposits and their relations to underlying materials. No description of them is undertaken, nor are any paleontological data recorded.

A paper by Berry[3] includes a list of fossils from the "Coal Mine," on the west side of Point Loma, which contains thirty-one species. These "Coal Mine" fossils are identical in age with those listed in the present paper.

Stephens[4] briefly discusses the occurrence of fossils on the Pleistocene terraces, and gives a small faunal list.

Geologic Setting of the Terrace

The terrace material from which the fauna was collected lies uncon-

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1 GRANT, U. S., and GALE, H. R. Catalogue of the Marine Pliocene and Pleistocene Mollusca of California and Adjacent Regions. Memoirs, San Diego Soc. Nat. Hist., Vol. 1, pp. 1-1036, 1931.

2 ELLIS, ARTHUR L., and LEE, CHARLES H. The Geology and Ground Waters of the Western Part of San Diego County, California. U. S. Geol. Surv. Water Supply Paper 446, pp. 1-321, 1919.

3 BERRY, S. STILLMAN. Fossil Chitons of Western North America. Calif. Acad. Sci. Proc., 4th ser., Vol. 11, pp. 399-536, 1922.

4 STEPHENS, FRANK. Notes on the Pleistocene Deposits of San Diego County, California. Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 245-256, 1929.

formably on sediments of Cretaceous age, called "Chico" by Ellis and Lee.[5] These Cretaceous rocks are mostly very fine-grained cherty and marly shales, rather carbonaceous in places. A small fauna has been reported from them by Fairbanks.[6] Associated with the terrace deposits are gravels of continental origin, which mostly overlie, but occasionally interfinger with the terrace sediments.

The terrace materials themselves are moderately fine-grained brownish to yellowish sands, with some conglomeratic material and much marl. The best collecting was near the base of the terrace directly overlying the Cretaceous shale. Here the fossils were well-preserved in marls that surround huge boulders of the Cretaceous shale. These are products of marine erosion on an old shoreline along which the terrace materials were deposited.

The maximum height of the terrace above sea level is about 100 feet (to the north) and the minimum twenty-five feet (to the south).

RELATION TO OTHER TERRACES

The position of the Point Loma terrace indicates that its uplift was produced by the last diastrophic movement of the southern coast,[7] since it is the lowest terrace exposed, and has, in part, at least, been destroyed by marine processes since the last diastrophism. This is further indicated by the fact that at least three older terraces have been recognized by Ellis and Lee,[8] and more by other workers. While no positive correlation of this lowermost terrace can be made with the terraces to the north and south, the fact that the Point Loma terrace shows a marked local increase in elevation from the south toward the north where it approaches the elevation of the La Jolla terrace of Hanna,[9] which he has shown to be the lowest exposed in the La Jolla Region, may be indicative of a similar age for the Point Loma and La Jolla terraces. Hanna, however, suggests correlation of his La Jolla terrace with the Chula Vista terrace of Ellis and Lee.[10] The Chula Vista terrace is, however, not the lowest one mapped by

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5 Op. cit., p. 51.

6 FAIRBANKS, HAROLD W. The Validity of the so-called Wallala Beds as a Division of the California Cretaceous. Amer. Jour. Sci., 3rd ser., Vol. 45, pp. 473-478, 1893.

7 ELLIS and LEE (op. cit.), and others, have shown that a slight submergence, producing the embayments of the San Diego coastal area, was the last diastrophic movement. This movement is not recorded in the Point Loma terrace.

8 Op. cit., p. 25, and plate VI.

9 HANNA, MARCUS A. Geology of the La Jolla Quadrangle, California. Univ. Calif. Pub., Bull. Dept. Geol. Sci., Vol. 16, pp. 187-246, 1926.

10 Op. cit., p. 26, and plate VI.

Ellis and Lee, but is the next to the lowest. From the account of Ellis and Lee, it seems that the Nestor terrace, said by them to have an elevation of from twenty-five feet to 100 feet above sea level, is more nearly the equivalent of the Point Loma terrace. This correlation is also suggested by Gale.[11]

The correlation of terraces in the region is complicated by the inability to trace terraces directly from one geographic locality to another, and by local warping known to have taken place in the Point Loma and adjacent blocks.

Climatic Inferences from the Fauna

Analysis of the fauna as a whole, and of each locality collection, was undertaken in an effort to determine climatic and temperature variations which are known to have taken place in the Pleistocene in other west coast localities.[12] Considering all those forms living only as far south as San Diego as dominantly *northern* forms and thus indicative of cooler water, and those ranging only as far north as Santa Barbara as *southern* forms and thus indicative of warmer water, one finds a consistently high percentage (64-65%) of the forms (for the whole fauna and for each locality) which indicate neither warm nor cold water (on the basis outlined above) and which are of wide geographic range. The balance is almost equally divided among northern and southern forms. The general percentages for the entire fauna are: northern, 16.6%; southern, 19.2%; intermediate, 64.1%. Thus a temperate water condition is indicated. This is additional evidence for each fauna coming from the same horizon in the lowermost terrace, as well as evidence for the water temperature having been essentially the same as today at the time the forms were deposited.

The absence from the fauna of such forms as *Chione gnidia, Dosinia ponderosa,* and *Turritella goniostoma,* which are found in other terraces of the San Diego region, and which do not live today[13] on the San Diego

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11 Gale, H. R., in Grant and Gale. Op. cit., p. 64.

12 Bailey, T. L. Lateral Change of Fauna in the Lower Pleistocene. Bull. Geol. Soc. Amer., Vol. 46, pp. 489-502, 1935. Clark, Alex. The Coolwater Timms Point Pleistocene Horizon at San Pedro, California. Trans. San Diego Soc. Nat. Hist., Vol. VII, pp. 25-42, 1931. Woodring, W. P. Fossils from the Marine Pleistocene Terraces of the San Pedro Hills, California. Amer. Jour. Sci., Vol. XXIX, pp. 292-305, 1935.

13 Professor Grant informs me that *Dosinia ponderosa* has been reported living in San Diego Bay today, but that this report is probably based upon fossil specimens which were thought to be Recent dead individuals.

coast, but live farther south, indicates that some change of water temperature (lowering) took place between the deposition of the upper terraces and those of Point Loma. Furthermore, the mean annual surface temperature of the seas where the above forms now live is respectively 63, 63, and 64 degrees Fahrenheit, while the mean annual surface temperature of the waters at San Diego is 62 degrees F.,[14] in which today live most of the forms found in the faunal list.

Gale[15] points out that the Nestor terrace, in which he includes the Point Loma terrace, contains warm water faunas like those of the Palos Verdes terraces. The data presented above show that the Point Loma terrace contains faunas indicative of temperatures like those of today, and not warmer. Since the faunas from which the temperature conditions were inferred by Gale, lived on the bay side of Point Loma, and on the landward side of San Diego and Mission bays, where they would have been protected from open ocean influences, one might expect warmer water facies in equivalent faunas on the landward side of an island separated from the mainland by a shallow coastal lagoon or strait, such as Point Loma was known to have been during the Pleistocene, prior to the last uplift.[16]

The presence of one specimen of *Tegula montereyi* in the collection, which is typically a northern form, and which has not been reported living farther south than the Santa Barbara Islands, would be of great significance in indicating a cooler water temperature, if other supporting evidence were forthcoming. The presence of so many facts indicating present day temperature conditions at the time of deposition, is strongly suggestive of the fact that *Tegula montereyi* of this fauna is a reworked or washed-in form; or, that its geographic range in the Pleistocene was greater than today.

In studying the geographic distribution of the fauna of the Point Loma terrace, Stephens[17] states that of those forms found: "Some have a southern distribution occurring now rarely or not at all this far north. More have a northern habitat."

The present survey, involving almost three times as many species as listed by Stephens, does not support this interpretation, since as many

14 Temperatures from data compiled by U. S. Grant.
15 GALE, H. R., in Grant and Gale. Op. cit., p. 64.
16 STEPHENS, FRANK. Op. cit., p. 248-49.
17 Op. cit., p. 249.

southern as northern forms were found in the fauna; in fact, a few more southern than northern.[18]

Thus it is seen that temperatures closely similar to those found today prevailed in this area and that no temperature variations of warm and cool water facies (either lateral or vertical) are indicated by this fauna.

Summary of the Ecologic Features of the Fauna

The fauna contained in the collection examined by the writer comprises a total of 102 species. Of these more than ninety per cent are living today on exposed coasts, in shallow water, near shore, generally between tides. None of the forms present are extinct. Ten per cent of the species whose habitat indicates deeper water or bay conditions are of large depth range in general. Assuming that the physical conditions and paleogeography at the time the forms lived were essentially as today, it seems reasonable to suppose that the bay forms were washed outside onto the outer coasts by the currents, and were deposited with the shore fauna.

A few forms, such as *Astrea inaequalis, Calliostoma turbinum, Diadora aspera, Tegula montereyi, Tritonalia interfossa,* and *Mitra idae,* which appear in the faunal list, generally are thought to be of deeper water habitat. They may be present in the fauna because they were washed up from deeper water. Some of them appear to be water-worn.

Age of the Terraces

Since the Nestor terrace bevels the Pliocene San Diego formation,[19] its post-San Diego age is unquestioned; and since the Nestor is either older than or equivalent to the Point Loma terrace, the Pleistocene age of the Point Loma terrace is strongly suggested. That this terrace is the result of the latest uplift of the region has already been shown.

The very youthful stage of erosion of the Point Loma terrace, which is incised with few, small, V-shaped, steep gradient arroyos, entering the sea at discordant elevations, indicates a brief lapse of time since the exposure of this lowermost terrace. Terraces to the south and east of

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18 Professor Grant informs me that many of the smaller gastropods in the collections of Mr. Stephens were identified for him by the late Mr. Tom Oldroyd, who, being much more familiar with the northern microscopic fauna than the southern, unconsciously assigned several doubtful specimens to northern forms which were probably really west Mexican species with which he was unfamiliar.

19 Ellis and Lee. Op. cit., p. 25.

Point Loma show much later physiographic stages. Thus a late Pleistocene age is indicated.

From a faunal standpoint, the Pleistocene age is supported by the fact that no extinct species are present in the fauna, and by the distinctly recent aspect of the faunal suite.

SUMMARY

The fauna of the Point Loma terrace in San Diego County, California, consists of over 100 species. The ecology of the species indicates an open, exposed coast, with shallow water, largely inter-tidal habitat. The age of the fauna is Pleistocene, probably late Pleistocene. The climatic conditions at the time the forms lived were similar to those found in the area today.

(For list of species and collecting localities, see following pages.)

CHECK LIST OF PLEISTOCENE FOSSILS, POINT LOMA PENINSULA

KEY TO ECOLOGIC FEATURES OF THE FAUNA

(A) On rocks, or in sand, between high and low tides, on reefs and moss.
(B) Along rocky shores and beaches, in the reach of the surf.
(C) Bay form; brackish water; tidal flats.
(D) Fairly deep water, on rocky bottom.
(E) On big kelp.
(F) On shells of *Tegula funebralis*.
(G) On eel grass, lettuce, and seaweed.
(H) Parasitic on star-fish and sea cucumbers.
(I) Nestler.
(J) Borer.

NAME	LOCALITIES KEY[20]							RANGE KEY[21]			
GASTROPODS	768	769	771	1185	1186	1187	1188	M	P	Pl	R
(A) Acanthina lugubris (Sowerby)	R	C	P	R		P	C			X	X
(A) Acanthina spirata (Blainville)	C									X	X
Acmaea sp.	A										
(A) Acmaea digitalis (?) textilis (Gould)	P										
(E) Acmaea insessa (Hinds)		C	A	C	R	P			X	X	X
Acmaea instabilis (Gould)				R							
(B) Acmaea (?) limatula (Gould)	R	C	A	C	P	C				X	X
(A) Acmaea mitra Eschscholtz in Rathke	A	C					C		X	X	X
(B) Acmaea paleacea Gould	C									X	X
(B) Acmaea scabra (Gould)	A	A		C	R		C			X	X
(B) Aletes squamigerus Carpenter	C	C	C	C			C			X	X
Amphissa sp.		C	R								
(A) Amphissa versicolor Dall	C									X	X
(A) Astrea (Pachypoma) inaequalis (Martyn)		R						X	X	X	X
(A) Astrea (Pomaulax) undosa (Wood)	P	R	R							X	X
Bittium sp.	C	P									
Calliostoma sp.	P										
(E) Calliostoma canaliculatum (Martyn)	P						P		X	X	X
(D) Calliostoma (?) turbinum Dall		P									
Chiton sp.	P			P							
(C) Cerithidea californica (Haldeman)			A						X	X	X
(A) Conus californicus Hinds	C	C	R	C		P	R		X	X	X
Crepidula sp.		P									
(A-D) Crepidula aculeata (Gmelin)	C	C	R	R			P		X	X	X
(F) Crepidula adunca Sowerby	A	R	P	C			R		X	X	X
(A-D) Crepidula lingulata Gould	C	P							X	X	X
(A-D) Crepidula nummaria Gould	R								X	X	X
(C) Crepidula onyx Sowerby			P					X	X	X	X
(D) Diodora aspera (Eschscholtz in Rathke)	P	P	R	P						X	X
Epitonium sp.		P									
(B) Epitonium (Nitidiscala) tinctum (Carpenter)	C									X	X
(A) Fissurella volcano Reeve	A	A	A	A	C	C	A	X	X	X	X
Fusinus sp.		R									
(A) Fusinus kobelti (Dall) variety monksae (Dall)	R	C	P			P	R		X	X	X
Gadinia sp.		P	P	R				X	X	X	X
(B) Gadinia (?) reticulata (Sowerby)	C									X	X
(A) Haliotis cracherodii Leach	R	P	C	P			R			X	X
(B) Haliotis corrugata Gray	R								X	X	X
(A) Haliotis rufescens Swainson			P						X	X	X
(A) Haminoea virescens (Sowerby)	R	R							X	X	X
Hipponyx sp.			P	R							
(A) Hipponyx antiquatus (Linnaeus)	C	C							X	X	X
(A) Hipponyx tumens Carpenter	C	C	C	C			C			X	X

[20] P—Present; R—Rare (2 - 5); C—Common (5 - 20); A—Abundant (20+).
[21] M—Miocene; P—Pliocene; Pl—Pleistocene; R—Recent.

GASTROPODS (Continued)	768	769	771	1185	1186	1187	1188	M	P	Pl	R
(B-A) Homalopoma carpenteri (Pilsbry)	A	C		C		R	P		X	X	X
(A) Hyalina (Hyalina) californica (Tomlin)		C								X	X
(A) Hyalina (Cystiscus) jewettii (Carpenter)	A	R								X	X
(?) Ischnochiton sp.			P								
(G) Lacuna (?) unifasciata Carpenter		R								X	X
(B) Littorina scutulata Gould	A	A	A	A	A		A			X	X
(B) Macron lividus (A. Adams)		R								X	X
(A) Mangelia (Mitromorpha) filosa (Carpenter)	P									X	X
(A) Mangelia (Mitromorpha) gracilior (Hemphill in Tryon)	C									X	X
(H) Melanella (?) rutila (Carpenter)	P									X	X
(D) Mitra idae Melvill			R	R		P	P		X	X	X
(B) Mitrella carinata (Hinds) variety gausapata (Gould)	A	A		C	P		R	X	X	X	X
(B-C-D) Nassarius (Schizopyga) mendicus variety cooperi (Forbes)		C	R	P				X	X	X	X
(E) Norrisia norrisii (Sowerby)	C	R	C	P	R	A	P			X	X
(A) Olivella biplicata (Sowerby)	C	C	R	C		R	A		X	X	X
(C-D) Retusa (Acteocina) culcitella (Gould)	R								X	X	X
Spirotropis (Antiplanes) sp.		R									
(A) Tegula (Chlorostoma) aureotincta (Forbes)	R									X	X
(B) Tegula (Chlorostoma) funebralis (A. Adams)	A	A	C	A	C	C	A		X	X	X
(D) Tegula montereyi (Fischer in Kieoer)		P								X	X
Tegula (Promartyn) pulligo Martyn		R	R								
Tritonalia sp.	P										
(D) Tritonalia foveolata (Hinds)	R	P								X	X
(D) Tritonalia interfossa (Carpenter)	C	R								X	X
Trophon sp.	P										
(B) Truncatella californica Pfeiffer		R								X	X
(B) Truncatella stimpsoni Stearns		R								X	X
Turbonilla sp.	C	P									
PELECYPODS											
Barbatia (Acar) pernoides (Carpenter)	P									X	X
(I) Cumingia lamellosa Sowerby	A	A	C	C	P	C	C			X	X
(D) Glaus carpenteri (Lamy)	A	A	P	C	R	C	R			X	X
(A) Hiatites multirugosus (Gale)			P						X	X	X
(D) Irus lamellifer (Conrad)		P		P			P		X	X	X
(B) Kellia suborbicularis (Montagu) variety laperousii (Deshayes)		P									
Lacuna sp.	R										
(C) Leptopecten latiauratus (Conrad)	P	P							X	X	X
(D) Lucina californica Conrad	C	C	A	A	A	A	C		X	X	X
(B) Mytilus (Mytilus) californianus Conrad	P	R								X	X
(C) Ostrea lurida Carpenter		R						X	X	X	X
(A-B-C) Pecten (Aequipecten) bellilamellatus Arnold	P								X	X	X
(A-B-C) Pecten (Aequipecten) circularis Sowerby		R	A						X	X	X
(J) Pectricola carditoides (Conrad)	R	R	C	R					X	X	X
(D) Platydon cancellatus (Conrad)			P	P				X	X	X	X
(D) Pododesmus macroschisma (Deshayes)			P						X	X	X
(D) Psephidia lordi (Baird) variety ovalis Dall		C							X	X	X
(A) Pseudochama exogyra (Conrad)		P	R	R			P		X	X	X
(B) Saxicava arctica (Linnaeus)	P							X	X	X	X
(B-C) Saxidomus nuttalli Conrad						P		X	X	X	X
(B) Semele decisa (Conrad)			R							X	X
(B) Semele rupicola Dall				R						X	X
(A) Septifer bifurcatus (Conrad)	A	A	C	C		P	C			X	X
(B) Tellina (?) meropsis Dall	C									X	X
(A-B) Venerupis (Protothaca) staminea (Conrad)	C	C	A	A			C	X	X	X	X
(B) Venus (Chione) succinta Valenciennes		P	P					X	X	X	X
OTHER FORMS											
Barnacle fragments	P										
Coral fragments	P										
Echinoid fragments	P						P				
Tetraclita squamosa (Bruguiere)	P										

FOSSIL LOCALITIES (C. I. T.)

768. Yellow fossiliferous marl from marine terraces about 100 feet above sea level, and about 100 yards southwest of the intersection of Ladera and Cordova Streets, and about 4 miles N12°W of the lighthouse on Point Loma, San Diego County, California. Sept. 22, 1930. Popenoe and Scharf.

769. Marine terrace 100 feet above present sea level, exposed on west side of Point Loma peninsula and about two miles N17½°W of the lighthouse on Point Loma, San Diego County, California. Pleistocene marls just above Eocene-Pleistocene contact. Sept. 22, 1930. Popenoe and Scharf.

771. Marine terrace about 100 feet above present sea level along ocean front on west side of Point Loma peninsula, about 100 yards north of the north boundary of Fort Rosecrans Military Reservation and about 3.1 miles N13°W of the lighthouse on Point Loma, San Diego County, California. Marls just above Eocene sandstones. Sept. 22, 1930. Popenoe and Scharf.

1185. Marine terrace about fifty feet above present sea level, exposed on west side of Point Loma peninsula, and about 200 yards south of the south boundary of the Theosophical Society grounds, on the Fort Rosecrans Military Reservation. Nearly on the contact between the terrace deposits and the Cretaceous. Point Loma peninsula, San Diego County, California. February 8, 1936. Popenoe and Webb.

1186. Marine terrace about fifty feet above present sea level, exposed on west side of Point Loma peninsula, and about three-tenths of a mile south of the south boundary of the Theosophical Society grounds, on the Fort Rosecrans Military Reservation. Nearly on the contact between the terrace deposits and the Cretaceous. Point Loma peninsula, San Diego County, California, February 8, 1936. Popenoe and Webb.

1187. Marine terrace about fifty feet above the present sea level, exposed on the west side of Point Loma peninsula, and about one-half mile south of the south boundary of the Theosophical Society grounds, on the Rosecrans Military Reservation. Nearly on the contact between the terrace deposits and the Cretaceous. Point Loma peninsula, San Diego County, California. February 8, 1936. Popenoe and Webb.

1188. Marine terrace about fifty feet above the present sea level, exposed on the west side of Point Loma peninsula, and about eight-tenths of a mile south of the south boundary of the Theosophical Institute grounds, on the Fort Rosecrans Military Reservation. Nearly on the contact between the terrace deposits and the Cretaceous. Point Loma peninsula, San Diego County, California. February 8, 1936. Popenoe and Webb.

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TRANSACTIONS

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DESCRIPTIONS OF NEW MAMMALS FROM ARIZONA AND SONORA, MEXICO

BY

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During the past four years there has been accumulated in the collection of the San Diego Society of Natural History a small series each of a number of mammals from southwestern Arizona and the northwestern coastal district of Sonora, Mexico. Study of this material has revealed the presence of several apparently undescribed races which are herewith named.

The writer wishes to express his gratitude and appreciation to Mrs. Florence V. V. Dickey and Mr. A. J. van Rossem for loan of specimens from the Dickey collections in Pasadena, California; to Dr. E. Raymond Hall of the Museum of Vertebrate Zoology, Berkeley, California, for the loan of comparative material; and to Mr. Bernard Bailey for the use of specimens from his private collection now on deposit in the Natural History Museum in San Diego, California. The skull illustrations are by Mr. Allan J. Stover.

Neotoma lepida aureotunicata subsp. nov.

PUNTA PENASCOSA DESERT WOOD RAT

Type.—From Punta Peñascosa, Sonora, Mexico; no. 10907, collection of the San Diego Society of Natural History; adult male; collected by Laurence M. Huey, February 14, 1934.

Characters.—A race of *Neotoma lepida* characterized by very bright buff color, with a suffusion of buffy over entire dorsal and belly surfaces of the body; tail bicolored, and feet white. The molar series of *aureotunicata* is slightly longer and heavier than that of either *Neotoma lepida flava* or *Neotoma lepida auripila.*

Measurements of 3 *Neotoma lepida aureotunicata*

Collection of S. D. S. N. H.	Sex	Total length	Tail	Hind foot	Ear	Greatest length of skull	Condylobasal length	Zygomatic breadth	Interorbital constriction	Nasals	Alveolar length of upper molar series
10852	♀	305	155	32	30	38.9	37.0	20.5	5.0	14.3	8.4
10907[1]	♂	292	141	31	27	37.5	36.2	19.6	5.1	14.2	8.2
10934	♂	305	141	30	25	39.3	37.5	20.0	5.0	15.2	8.2

Range.—Known only from the type locality.

Comparisons.—Compared with *N. l. flava* from Tinajas Altas, Gila Mountains, Yuma County, Arizona, *N. l. aureotunicata* is much deeper in color, with a bicolored tail, dark ears and slight buffy suffusion on belly. Compared with *N. l. auripila*, from Agua Dulce Mountains, Pima County, Arizona, much brighter in color, with less blackish cast dorsally, bicolored tail and lighter buffy suffusion on belly. Blossom (Occas. Papers of the Museum of Zoology, Univ. of Michigan, No. 315, May 29, 1935) described a smallish, dark form, *N. l. bensoni* from the Pinacate lava beds, Sonora Mexico. I have not seen specimens of *bensoni*, but from the description, it is a much darker race than *aureotunicata* and confined to the black lava of the Pinacate region.

Remarks.—The three specimens which form the basis of this newly described race were taken from a small group of rocky hills that form the promontory of Punta Peñascosa. This locality is completely isolated as far as terrain inhabitable by *Neotoma lepida* is concerned. The nearest locality this species is known to inhabit is the Pinacate range, which lies over twenty miles northward and is separated from Punta Peñascosa by that distance of bleak, sandy, level desert, an association hostile to the species. From the experience of the writer and from published accounts of the general region, it would seem that *Neotoma lepida* inhabits the higher rocky slopes of all these desert ranges in southwestern Arizona and adjacent Sonora. In most cases this rocky type of habitat is separated by intervening valleys and wide plains of sandy desert, which are uninhabitable by this species. Thus biological islands are formed and the *Neotoma lepida* population is divided into isolated groups. As with islands in the sea, the smaller the area the more susceptible are the inhabitants to specialized development. In fact further study and exploration of this general desert region, both in southwestern Arizona and northwestern Sonora, will without doubt bring to light additional well-marked races of this species.

Specimens examined.—*Neotoma lepida auripila*: 3 from Agua Dulce Mountains, 7 miles east of Papago Well, Pima County, Arizona; *Neotoma lepida flava*: 4 from Tinajas Altas, Yuma County, Arizona; *Neotoma lepida aureotunicata;* 3 from type locality as above.

[1] Type.

Neotoma lepida harteri[2] subsp. nov.

GILA BEND DESERT WOOD RAT

Type.—From 10 miles south of Gila Bend (or, exactly, from the summits of a group of lava hills on the east side of the Ajo railroad, about 2 miles north of Black Gap), Maricopa County, Arizona; no. 11462, collection of the San Diego Society of Natural History; adult male; collected by Laurence M. Huey, February 8, 1936.

Characters.—A dark, blackish-colored race of *Neotoma lepida* with medium body size, relatively long tail and small hind feet. In body size *harteri* is larger than its southern relatives, *N. l. auripila* or *N. l. flava*, more nearly approaching the average body measurement given by Benson in his paper describing *N. l. flava* (Occas. Papers of the Museum of Zoology, Univ. of Michigan, No. 317, July 1, 1935, table, pp. 4-5) for *Neotoma lepida devia* from the Painted Desert in northern Arizona, which is the region nearest the type locality of *devia* from which he had specimens. However, in color *harteri* is quite different from the three forms above mentioned, being dark (nearly black) dorsally, with the under color tending towards grayish rather than towards the buffy cast found in the southern Arizona and Sonoran forms of *N. lepida*. The tail of *harteri* is dark (nearly black), in about 60% of the specimens examined varying but slightly on the ventral side to dusky, and in the remainder uniformly colored above and below. In this tail character *harteri* stands apart from all the specimens of either *auripila, flava* or *devia* so far examined. The ears of *harteri* are deep, dusky black. The median line on the side is buffy, with a buffy suffusion covering the belly. A white pectoral patch and a white inguinal patch of relatively large size are present on all the specimens of this race examined. These white patches approach in size those of *devia* and are not restricted to a small area as in *auripila*. Cranially, *harteri* compares closely with *auripila* and *flava*, but differs slightly from *devia* in a few minor characters.

Measurements.—*Type*: Total length, 280; tail, 135; hind foot, 29; ear, 28. *Skull* (*type*): Greatest length, 36.5; condylobasal length, 34.6; zygomatic breadth, 19.9; interorbital constriction, 5.4; nasals, 13.0; alveolar length of upper molar series, 7.3.

Range.—So far as known, the hills south of Gila Bend, Arizona, but further collecting may reveal *N. l. harteri* to have an extensive range in the desert mountains to the eastward of the type locality.

Specimens examined.—Besides the list mentioned in the preceding description:—*Neotoma lepida devia*: 5 from Hoover Dam Ferry, Mohave County, Arizona; 3 from Mud Spring, 12 miles WSW of Chloride, Mohave County, Arizona; 3 from foot of The Needles, Colorado River, Mohave County, Arizona; 1 from Colorado River above Bill Williams River, Mohave County, Arizona; 2 from 10 miles below Cibola, Colorado River, Yuma County, Ari-

[2] It gives the writer pleasure to dedicate this race to Samuel George Harter who as a youth chose natural science as his life-work and has been the writer's companion on many desert collecting trips.

zona; 4 from base of Castle Dome, Yuma County, Arizona; 2 from 10 miles east of Quartzsite, Yuma County, Arizona. *Neotoma lepida harteri*: 9 from type locality as above.

Ammospermophilus harrisii kinoensis subsp. nov.

SONORA ANTELOPE GROUND SQUIRREL

Type.—From Bahia Kino, Sonora, Mexico; no. 11284, collection of the San Diego Society of Natural History; adult female; collected by Laurence M. Huey, February 22, 1935.

Characters.—This race is characterized by being darker and more grizzled dorsally and having lighter-colored hind feet than either *Ammospermophilus harrisii harrisii* or *Ammospermophilus harrisii saxicola.* The molar teeth are smaller and the tooth row is slightly shorter than in either of the other races mentioned. *A. h. kinoensis* also differs from *saxicola* in having larger hind feet.

Measurements.—Type: Total length, 229; tail, 80; hind foot, 40; ear, 5. *Skull (type)*: Greatest length, 38.3; zygomatic breadth, 23.2; interorbital constriction, 10.8; nasals, 10.8; alveolar length of upper molar series, 6.8; longitudinal length of bullae, 9.9.

AVERAGE MEASUREMENTS OF *Ammospermophilus harrisii*

Locality	Total length	Tail	Hind foot	Greatest length of skull	Zygomatic breadth	Interorbital constriction	Alveolar length of upper molar series	Nasals	Longitudinal length of bullae
Tinajas Altas	230.3[3]	80.4	37.7	38.0	22.6	9.7	7.0	11.6	9.8
Camp Verde	232.2[4]	80.8	39.8	40.0[5]	23.6	10.3	7.0	10.3	10.6
Bahia Kino	234.5[6]	83.0	40.2	39.2	22.9	10.4	6.8	11.3	9.7

Range.—So far as known, coastal district of Sonora, Mexico, from Porto Libertad south to Bahia Kino.

Remarks.—The fact that Audubon and Bachman named *A. harrisii* without giving a locality from which the original specimen was collected has led to some speculation. Merriam (N. A. Fauna, No. 2, Oct. 30, 1889, pp. 19-20) properly allocated this species to southern and western Arizona; and since then Mearns (Proc. U. S. Nat. Museum, Vol. 18, p. 444 — advanced sheets published March 25, 1896) divided the species into two races, describing his form *A. h. saxicola* from Tinajas Altas, Yuma County, in southwestern Arizona. Comparison of Arizona material substantiates the fact that two tenable forms are existent in the

[3] 15 specimens.

[4] Body measurements taken from table of 20 specimens in Mearns, Mam. of Mex. Boundary, pp. 307-308.

[5] Skull measurements from 7 specimens in collection of Bernard Bailey.

[6] 7 specimens.

area south and west of the great Mogollon plateau, though there is still a question of how the names may, in the future, be applied. The crux of this question lies in the possibility of some future student being able to designate the type locality of *A. harrisii*. The writer has followed Mearns and used the measurements of specimens from Fort (= Camp) Verde, Arizona, as most typical of the race *harrisii*.

When adequate material is assembled "the long tail" character assigned by Mearns to his race *saxicola* vanishes. However, the specimens from southwestern Arizona are discernible by their lighter coloration. In fact, color is the main character by which the group *harrisii* has been divided into these races, and this character is more readily seen in series than individually.

Specimens examined.—Ammospermophilus harrisii harrisii: 8 from Camp Verde, Yavapai County, Arizona; tabulated body measurements of 20 specimens from same locality (see Mearns, Mam. of Mexican Boundary of United States, Bull. U. S. Nat. Mus., No. 56, pp. 307-308); 2 from Wickenburg, Maricopa County, Arizona; 5 from 6 miles northeast of Paradise, Cochise County, Arizona; 1 from 25 miles south of Tucson, Pima County, Arizona; 1 from 5 miles northwest of Sells, Pima County, Arizona. *Ammospermophilus harrisii saxicola*: 15 from Tinajas Altas, Gila Mountains, Yuma County, Arizona (type locality); 3 from 7 miles east of Papago Well, Pima County, Arizona; 3 from Punta Peñascosa, Sonora, Mexico. *Ammospermophilus harrisii kinoensis*: 6 from Porto Libertad, Sonora Mexico; 7 from Bahia Kino, Sonora, Mexico (type locailty).

Thomomys bottae growlerensis subsp. nov.

GROWLER VALLEY POCKET GOPHER

Type.—From 7 miles east of Papago Well, Pima County, Arizona (or, exactly, along a well wooded desert wash on the southwestern side of a range of hills in the southern end of Growler Valley; the Agua Dulce Mountains form the southern boundary of this locality and are not far distant); no. 12387, collection of the San Diego Society of Natural History; adult male; collected by Laurence M. Huey, March 16, 1937.

Characters.—In color *Thomomys bottae growlerensis* differs from *T. b. phasma*, its nearest western relative, by being brighter, more golden and lacking the pallid appearance of either *T. b. phasma* or *T. b. depauperatus*. The skull of *growlerensis*, compared with those of *T. b. phasma* and *T. b. vanrossemi* (this latter form from Punta Peñascosa, Sonora, but in the same general desert area) is narrower, the zygomatic arches are less sharply angled and the audital bullae are more rounded. The interpterygoid space of *growlerensis* is narrower than that of *phasma* and wider than that of *vanrossemi*.

Measurements.—Type: Total length, 208; tail, 62; hind foot, 30; ear, 5. *Skull (type)*: Condylobasal length, 37.4; spread of maxillary arches, 22.7; interorbital constriction, 6.7; nasals, 13.3; alveolar length of upper molar series, 7.5.

Range.—Known only from the type locality.

Specimens examined.—Thomomys bottae phasma: 9 from Tule Well, Yuma County, Arizona (near type locality). *Thomomys bottae depauperatus*:

15, of which 9 were from 2 miles north of Tinajas Altas (= 7 miles south of Raven Butte), and 6 from proximity of Tinajas Altas, Yuma County, Arizona. *Thomomys bottae vanrossemi*: 12, including type, from Punta Peñascosa, Sonora, Mexico. *Thomomys bottae growlerensis*: 8 from the type locality as given above..

Thomomys bottae comobabiensis subsp. nov.

Comobabi Pocket Gopher

Type.—From 5 miles northwest of Sells, Pima County, Arizona (elevation, approximately 2400 feet); no. 12460, collection of the San Diego Society of Natural History; adult female; collected by Laurence M. Huey, March 22, 1937.

Characters.—A medium-sized, brownish-colored gopher, more nearly resembling those found on the higher parts of the mountains of south-central Arizona. The skull resembles that of *Thomomys bottae modicus*, but is smaller, with rounder, more inflated bullae and relatively shorter, heavier rostrum.

Measurements.—Type: Total length, 215; tail, 70; hind foot, 28; ear, 4. *Skull (type)*: Condylobasal length, 35.7; spread of maxillary arches, 21.4; interorbital constriction, 6.5; nasals, 12.1; alveolar length of upper molar series, 7.6.

Range.—Known only from the type locality.

Remarks.—Goldman described *Thomomys bottae pusillus* (Journ. Wash. Acad. Sciences, Vol. 21, No. 17, Oct. 19, 1931, p. 422) from a single adult female specimen. The measurements given by him indicate *pusillus* to be a diminutive form, not approaching the size of the race here described.

Specimens examined.—Thomomys bottae modicus: 4 from Tubac, Santa Cruz County, Arizona; 11 from Santa Cruz River, 2 miles south of Tumacacori Mission, Santa Cruz County, Arizona; 2 from Tucson, Arizona; 12 from Fort Lowell, Pima County, Arizona. *Thomomys bottae comobabiensis*: 7 from the type locality as given above.

Thomomys bottae aridicola subsp. nov.

Gila Bend Pocket Gopher

Type.—From 10 miles south of Gila Bend (or, exactly, on Ajo railroad right of way, about 2 miles north of Black Gap), Maricopa County, Arizona; no. 11424, collection of the San Diego Society of Natural History; adult female; collected by Laurence M. Huey, February 1, 1936.

Characters and Remarks.—A medium-sized, slightly tawny-appearing gopher, tending in color towards the preceding form described in this paper rather than towards the more buffy pallid types of gophers inhabiting the desert regions to the westward. In skull characters, the resemblance lies in the same direction, but *aridicola* has a longer, more flattened brain-case, with wider-spreading zygomatic arches and a more slender rostrum. The skull of *aridicola* is weak and light-boned and may show a relationship to *T. b. subsimilis*. *T. b. aridicola*

is not related to either *T. harquahalae* or *T. b. cervinus*, as comparison of measurements clearly demonstrates. The incisors do not project beyond the nasals.

Measurements.—Type: Total length, 212; tail, 63; hind foot, 29; ear, 5. *Skull (type)*: Condylobasal length, 36.7; spread of maxillary arches, 23.5; interorbital constriction, 6.8; nasals, 12.9; alveolar length of upper molar series, 7.5.

Range.—Known only from the type locality.

Specimens examined.—Thomomys bottae aridicola: 2 from type locality as given above. *Thomomys bottae cervinus*: 11 from Phoenix, Maricopa County, Arizona.

Perognathus intermedius lithophilus subsp. nov.

PORTO LIBERTAD ROCK POCKET MOUSE

Type.—From Porto Libertad (or, exactly, the summit of a rocky hill 1½ miles NNW of the fresh water spring on the beach), Sonora, Mexico; no. 11211, collection of the San Diego Society of Natural History; adult male; collected by Laurence M. Huey, February 5, 1935.

Characters.—Perognathus intermedius lithophilus is darker and more grayish dorsally than either *Perognathus intermedius intermedius* or *Perognathus intermedius phasma* and lacks the pinkish cast found in these two northern races. In size *lithophilus* resembles *phasma* and is slightly smaller than *intermedius*. Cranially, the mastoid bullae are less extended and the posterior part of the skull is slightly more arched and deeper than in either of the other two mentioned forms.

Measurements.—Type: Total length, 166; tail, 91; hind foot, 19; ear, 5. *Skull (type)*: Occipitonasal length, 23.5; mastoid breadth, 12.7; interorbital constriction, 6.2; nasals, 9.3; alveolar length of upper molar series, 3.4. Eight specimens including the type averaged: Total length, 166.8 (162-170); tail, 91.7 (82-97); hind foot, 20.1 (19-21); ear, 5. Skull: occipitonasal length, 23.3 (22.4-24.2); mastoid breadth, 12.6 (12.2-12.9); interorbital constriction, 6.0 (5.9-6.2); nasals, 9.0 (8.8-9.3); alveolar length of upper molar series, 3.2 (3.1-3.4).

Range.—So far as known, the vicinity of Porto Libertad, Sonora, Mexico.

Specimens examined.—Perognathus intermedius intermedius: 48 from Castle Dome, Yuma County, Arizona; 1 from Ehrenberg, Yuma County, Arizona. *Perognathus intermedius phasma*: 53 from Tinajas Altas, Yuma County, Arizona. *Perognathus intermedius lithophilus*: 9 from Porto Libertad, Sonora, Mexico (type locality).

Perognathus longimembris pimensis subsp. nov.

PIMA SILKY POCKET MOUSE

Type.—From 11 miles west of Casa Grande, Pinal County, Arizona; no. 12579, collection of the San Diego Society of Natural History; adult male; collected by Laurence M. Huey, May 22, 1937.

Characters.—The dorsal color of the type of *P. l. pimensis* is darker than *P. l. bombycinus*, nearly matching Ridgway's Avellaneous (Nom. of Color,

1912). This ground color resembles that of *P. l. panamintinus*, but *pimensis* lacks the blackish tipped hairs found on *panamintinus*. Cranially, these two races differ widely. The skull of *pimensis* is slightly larger than that of *bombycinus* and has a more rounded brain case and deeper, more inflated mastoid bullae. The zygomatic arches are more widely spreading anteriorly. The interparietal is small, nearly equal-sided, though this character is not one that can be used in contrast with *bombycinus*, but rather one that is shared with it and used when comparing with all other members of the *longimembris* group except *P. l. kinoensis* from Sonora, Mexico. In fact it is notable that these southwestern Arizona and Sonora forms of *longimembris* may be grouped by this character.

Measurements.—Type: Total length, 144; tail, 83; hind foot, 18; ear, 4. *Skull (type)*: Greatest length, 21.2; mastoid breadth, 12.2; interorbital constriction, 5.0; nasals, 7.4; tooth row, 2.7.

Range.—So far as known, from the vicinity west of Phoenix, Maricopa County, Arizona, south to the type locality west of Casa Grande, Pinal County, Arizona.

Remarks.—Records of *Perognathus longimembris* from Arizona are few. Osgood (Proc. Bio. Soc. Wash., Vol. 20, p. 19, Feb. 23, 1907) described *Perognathus bombycinus* (now *P. longimembris bombycinus*) from Yuma, basing his description on one specimen from that locality and two from northwestern Sonora, Mexico. Grinnell subsequently recorded (Univ. Pub. in Zool., Vol. 12, No. 4, p. 243, March 20, 1914) eighteen specimens of *P. bombycinus* taken on the Arizona side of the Colorado River at Ehrenberg. In 1931 Goldman described *Perognathus longimembris arizonensis* (Proc. Bio. Soc. Wash., Vol. 44, p. 134, Oct. 17, 1931) from 10 miles south of Jacobs Pools, Houserock Valley, north side of Marble Canyon of the Colorado River, Arizona. This form ranges north of the Grand Canyon and into southern Utah. Nine specimens from two localities in Arizona and one in Utah were represented in this description. So far as the writer is aware, these are the only localities of occurrence of *Perognathus longimembris* hitherto recorded for Arizona.

On October 17, 1930, Bernard Bailey collected a single specimen of *Perognathus longimembris*, now in the collection of the San Diego Society of Natural History, at Marinette, Maricopa County, Arizona; and on May 21 and 22, 1937, the writer captured two male specimens in a sandy area 11 miles west of Casa Grande, Pinal County. It is upon these three specimens that the present description is based. The single specimen from Marinette is in winter pelage and is darker and grayer than the Casa Grande specimens. It also does not have as well developed cranial characters, but is sufficiently close to *pimensis* to be included in the new race. However, a good series might prove it to be worthy of subspecific separation.

Specimens examined.—Perognathus longimembris kinoensis: 4 from Bahia Kino, Sonora, Mexico (including the type). *Perognathus longimembris bombycinus*: 2 from 6 miles east of Yuma, Arizona (type locality); 2 from 3 miles west of Pilot Knob, Imperial County, California; 3 from San Felipe, Lower California, Mexico. *Perognathus longimembris bangsi*: 3 from Palm Springs, Riverside County, California (type locality); 8 from below San Felipe Narrows, San Diego County, California. *Perognathus longimembris panamintinus*: 15 from

Junction Ranch, Argus Mountains, Inyo County, California; 6 from Nemo Canyon, Panamint Mountains, Inyo County, California; 7 from Harrisburg Flat, Panamint Mountains, Inyo County, California; 4 from mouth of Goler Canyon, Panamint Valley, Inyo County, California. *Perognathus longimembris pimensis*: 1 from Marinette, Maricopa County, Arizona; 2 from 11 miles west of Casa Grande, Pinal County, Arizona (type locality).

Bassariscus astutus yumanensis subsp. nov.

YUMA CACOMISTLE

Type.—From Tinajas Altas, Gila Mountains, Yuma County, Arizona; no. 12272, collection of the San Diego Society of Natural History; adult male; collected by Laurence M. Huey, March 6, 1937.

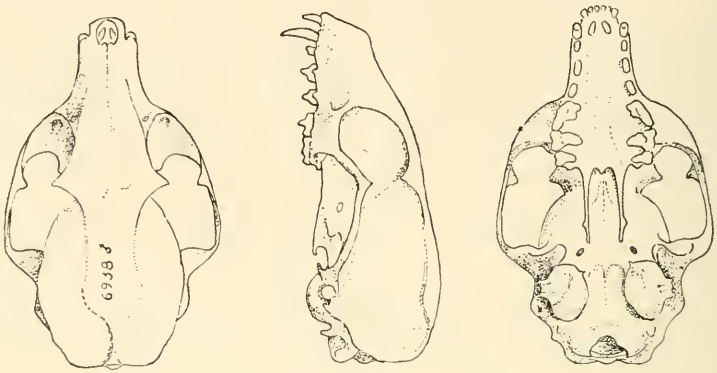
Characters and Comparisons.—A race of *Bassariscus astutus* differing from *B. a. arizonensis* of central and eastern Arizona in slightly smaller size, lighter dorsal color and having heavier proportions of black in the bands on the upper side of the tail. In this latter character *B. a. yumanensis* is similar to *B. a. octavus* of southern California, but has a more pallid color dorsally. Cranially *yumanensis* differs from both of the above mentioned races in having a smaller skull, with shorter, heavy rostrum, a more curving tooth row, a shallower brain case, and the tympanic bullae slightly shorter in length but rounder and much more deeply expanded when viewed in profile. (See Plate 23).

MEASUREMENTS IN MILLIMETERS

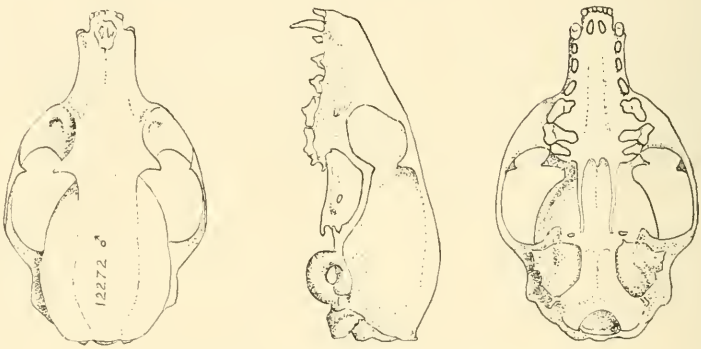
Collection of S. D. S. N. H.	Sex	Total length	Tail	Hind foot	Ear	Greatest length of skull	Condylobasal length	Zygomatic breadth	Breadth of rostrum over root canine	Interorbital constriction	Canine-molariform tooth row
12226	♀	727	380	60	39	73.0	72.2	43.4	12.3	17.2	29.1
12271	♀	700	358	63	41	72.3	71.6	44.0	12.6	16.2	28.7
12272[7]	♂	738	395	66	46	75.1	74.8	46.6	12.7	15.8	29.8

Remarks.—The race *B. a. yumanensis* represents another form of lighter-colored, subspecifically different mammals from the southwestern desert section of Arizona. The range of *Bassariscus astutus* extends from Transition Zone in the north to Lower Sonoran or even Arid Tropical in the south. This provides a wide latitude of environmental conditions, and, as a result, when a good assemblage of specimens is brought together from widely separated localities, the effects of varied habitat are quickly discernible. This is true as regards both color and size. For example *yumanensis* has size tendency towards the Lower California form *palmarius*, but stands apart in color tone, as would be expected when the climatic variation of their two ranges is compared. Similarly, conditions of

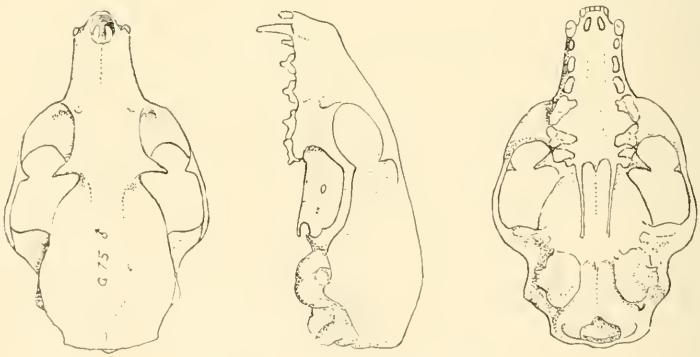
[7] Type.



Bassariscus astutus arizonensis.



Bassariscus astutus yumanensis. (Type)



Bassariscus astutus octavus.

Comparison of *Bassariscus* skulls. ×3/5

habitat are reflected in the appearance of the other races of the species.

There are two trapper-taken specimens in the Dickey collection labeled from Laguna Dam, Imperial County, California. Both of these specimens lack skull, front feet and measurements. One of them (no. 9975) is fairly representative in color of the race *yumanensis*, but the other (no. 9976) is doubtful and, judging from tail characters, is probably referable to *arizonensis*. However, without a skull the identity of this latter specimen cannot be definitely determined. The writer has positive knowledge of the presence of *Bassariscus* at this California locality, and he also knew the trapper and something of his travels. At the time these specimens were taken, he was a prospector, trapping as a side line, and was often away on short excursions into territory east of Tucson, Arizona, well within the range of *arizonensis*. His failure to appreciate the need of scientific accuracy, and the resemblance of no. 9976 to *arizonensis*, would tend to disqualify the locality data on this specimen.

Range.—Mountains of the arid region in extreme southwestern Arizona and southeastern California, and probably in contiguous territory of northwestern Sonora.

Specimens examined.—*Bassariscus astutus arizonensis*: 2 from 14 miles east of Fort Lowell, Pima County, Arizona. *Bassariscus astutus octavus*: 2 and 1 skull from San Luis Rey River, altitude 1700 feet, near Escondido, San Diego County, California; 1 from Bear Flat, San Antonio Canyon, Los Angeles County, California. *Bassariscus astutus raptor*: 1 from Eel River Bridge, Mendocino County, California; 1 from Low Gap, Trinity County, California; 1 from Hyampom, Trinity County, California; 1 from Bridgeville, Humboldt County, California; 2 from Eldridge, Sonoma County, California. *Bassariscus astutus palmarius*: 6 from San Ignacio, Lower California, Mexico. *Bassariscus astutus insulicola*: 2 from San José Island, Lower California, Mexico. *Bassariscus astutus saxicola*: 2 from Espíritu Santo Island, Lower California, Mexico. *Bassariscus astutus yumanensis*: 3 from Tinajas Altas, Gila Mountains, Yuma County, Arizona (type locality); 1 from Laguna Dam, Imperial County, California.

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

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A NORTHWESTERN RACE OF THE MEXICAN BLACK HAWK

BY

A. J. VAN ROSSEM AND THE MARQUESS HACHISUKA
Dickey Collections, California Institute of Technology

Recently, when the writers were shown a breeding pair of Mexican Black Hawks collected by Mr. W. J. Sheffler in southeastern Arizona, we at once recognized them as something quite distinct from typical *Buteogallus anthracinus anthracinus* of southern Mexico and Central America. Mr. Sheffler generously allowed us to borrow these specimens for study and our investigations show that a well-marked race is present in northwestern Mexico and the contiguous parts of the United States. This race we name as

Buteogallus anthracinus micronyx subsp. nov.

Type.—Breeding male adult, no. 1477, collection of W. J. Sheffler; Arivaipa Creek, Graham County, Arizona, June 3, 1936; collected by W. J. Sheffler.

Subspecific characters.—Most closely resembling *Buteogallus anthracinus anthracinus* (Lichtenstein) of southern Mexico and Central America, but general coloration paler and more brownish plumbeous (less blackish); mottling on under wing coverts and remiges more extensive and, in the latter instance, tending to gray rather than buff or reddish brown; lores and sub-ocular streak pure white instead of buff or pale buff. In the matter of size, *micronyx* has a longer wing and tail, and shorter, more slender claws. Juvenile very much paler than the corresponding stage of *anthracinus*, the ground color being nearly white and the ventral streaking narrow.

Range.—Southern Arizona, south to western Chihuahua and southern Sonora.

Remarks.—Lichtenstein's type of *Falco anthracinus* was collected by Deppe on his first (von Sack) trip to Mexico and therefore came from southeastern or

southwestern Mexico. This type is now in the Berlin Museum and was examined by van Rossem in 1933, but his notes and measurements concerning the specimen have unaccountably disappeared. However, three specimens from the state of Vera Cruz (Alvarado; Pasa Nueva) and one from Tehuantepec (all in the Museum of Vertebrate Zoology) belong unmistakably with the southern race. We are unable to perceive any significant differences between black hawks from southern Mexico and those from Guatemala, and El Salvador. However, two specimens from Limon, Costa Rica (Dickey collection), are more intensely black below than any typical *anthracinus* examined, and in addition have notably larger and more powerful feet and claws. Additional material may show the existence of a southern Central American race, in which case the name of *Buteogallus anthracinus bangsi* (Swann) will probably be applicable.

Measurements.[1]—

Adult Males	*Wing*	*Tail*	*Middle Claw*	*Hind Claw*
2 *micronyx* from Arizona and Sonora	365-385	220-222	19.0-19.7	21.5-22.5
4 *anthracinus* from southern Mexico and Central America	355-360	195-200	21.5-22.0	25.0-25.1
Adult Females				
3 *micronyx* from Arizona and Sonora	395-398	222-237	20.0-23.0	24.0-26.0
6 *anthracinus* from southern Mexico and Central America	370-390	204-220	22.5-25.5	26.0-27.8
2 *anthracinus* (?) from Costa Rica	385-390	218-226	28.0-29.5	31.1-33.1

Specimens examined.—*B. a. anthracinus*, Mexico, 6; Guatemala, 1; El Salvador, 10; Costa Rica, 2. *B. a. microynx*, Chihuahua, 1 (Colonio Pacheco); Sonora, 4 (Sonora; Alamos; Guirocoba); Arizona, 2 (Arivaipa Creek). *B. a. subtilis*, El Salvador, 8.

[1] Immature birds approximate adults in measurements save that almost invariably they have longer tails.

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TRANSACTIONS

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A NEW SNAKE OF THE GENUS SONORA FROM MEXICO

BY

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Through the kindness of Robert Hoard of San Diego State College, I have received a *Sonora* from the state of Sonora, Mexico, which, while obviously related to *Sonora occipitalis,* the Shovel-nosed Ground Snake of southeastern California and southwestern Arizona, differs conspicuously from that species in pattern. It is likewise somewhat low in ventral scale counts, although the significance of the latter difference cannot be determined until more specimens of the new form are available. The territory intervening between the most southerly known specimens of *S. occipitalis* (these are from southern Arizona), and the type locality of the new snake (central Sonora) is suitable in character to either form, consequently the two may later be shown to intergrade. However, the extreme southerly specimens of *S. occipitalis,* as compared with those from the center of its range, do not show directive character trends toward the new form. I therefore deem it advisable to consider it a full species, until intergradation be demonstrated, and suggest for it the name of

Sonora palarostris sp. nov.

Sonoran Shovel-nosed Ground Snake

Holotype.—No. 26,771 in the collection of LMK. Collected 5 miles south of Magdalena, Sonora, Mexico, by George Lindsay, April, 1937.

Diagnosis.—A *Sonora* resembling *S. occipitalis* in configuration, but with fewer dorsal blotches and with a low ventral scale count. An examination of 219

specimens of *S. occipitalis* reveals from 18 to 40 black dorsal rings on the body, the average being 26.3. The holotype of *S. palarostris* has 10 black rings. *S. occipitalis* males have from 147 to 170 ventrals, the average being 155; *S. palarostris* has 144.

Description of the Type.—Adult male.The head is somewhat wider than the neck, and is narrowed anteriorly. The snout is wedge-shaped in profile, with the lower jaw inset, the rostral projecting beyond the mental. The rostral is wider than high, recurved above, and deeply concave below; it extends farther backward below than above. The scales on the top of the head consist of a pair of internasals, which are wider than long; a pair of prefrontals which widen laterally; a large hexagonal frontal; a pair of supraoculars, not conspicuously imbricate and shorter than the frontal; and a pair of contacting parietals, considerably larger than the frontal, and one-third longer than wide. The nasal is small, entire, longer than high, and with the nostril somewhat posterior to the center. There is a single loreal on each side, smaller than the nasal, and longer than high. The preoculars are 1—1; postoculars 2—2, the lower being the smaller. The temporals are 1+2. There are 7 supralabials; the 6th is the largest; the 3rd and 4th contact the eye. The mental is small and quadrangular. There are eight infralabials, the first pair contacting on the median line; the fourth is the largest. The chin shields are in two pairs; the first pair in contact and nearly twice as long as the second; the latter are separated by a single gular. There are six gulars between the posterior tips of the first chin shields and the first ventral. The dorsal scale rows number 15—15—15; they are smooth and polished, with single apical scale-pits. The ventrals number 144; anal divided; subcaudals 39, all divided except the rather blunt terminal scale.

The pattern consists of alternating black and red rings or blotches, separated by narrow strips of yellow ground color.[1] There are 10 black rings on the body and 3 on the tail, the last being at the tail tip. The black rings are about twice the width of the yellow separating strips, and the red rings or blotches in turn have about twice the longitudinal extent of the black. In terms of dorsal scales (end to end) the rings have approximately the following widths: yellow, 1¾ scales; black, 3½ scales; red, 6½ scales. Both the black and red rings narrow on the sides, so that laterally the ground color is more in evidence than dorsally. The anterior black ring does not contact the ventrals; the second, while not complete, is represented ventrally by a pair of black spots. The third and all subsequent black rings completely encircle the body. They widen ventrally, compared with their lateral extent, but are not as wide as on the mid-dorsal line. The red blotches fade out laterally at the first row of scales above the ventrals; the two red rings on the tail are complete ventrally, but none on the body crosses the ventrals. There are a few black dots irregularly disposed in the red areas.

The snout is cream colored. There is a large black parietal blotch covering the posterior 2/3 of the frontal and extending to the posterior edge of the parietals; on the sides the blotch engages the eyes and the upper edges of the posterior supralabials. While this blotch is analogous to the crescent-shaped black blotch

[1] The ring arrangement formula is that usually given as distinguishing the coral snake from various harmless snakes.

characteristic of *S. occipitalis*, in this form it is more rectangular. The underside of the head is cream. Referring to Ridgway (Color Standards, 1912), the three dorsal colors of the alcoholic type are Maize Yellow, Brazil Red, and Black; these colors were observed shortly after preservation. The ventral shade is Cream Color.

The length over-all is 312 mm.; tail length 57 mm. The pupil of the eye is round.

Habits.—The type specimen was found abroad crawling across the road at about seven o'clock in the evening. From the likeness to *S. occipitalis* it may be assumed that this snake is a burrower; however, the top of the head is slightly convex from frontal to rostral, whereas in *S. occipitalis* this digging wedge is flat, or may even be dished. The type contained the remains of a large spider.

Remarks.—The number of black cross-bands on the body in *S. occipitalis* is a relatively constant character. Statistics of specimens ranging from Inyo County to Imperial County in California, and eastward in Arizona to Wickenburg and Picacho, are as follows:

Range	18 to 40 bands[2]
Mean	26.3 ± 0.18 bands
Standard deviation	4.03 bands
Interquartile range	23.6 to 29.0 bands
Coefficient of variation	15.3 per cent

There is some tendency of the number of bands to increase as we go north from the southern border of California to Kern and Inyo Counties, but the Arizona specimens, nearest to the probable range of *palarostris*, are not low. Thus there is no directive tendency toward intergradation, as far as cross-bands are concerned. The deviation of the *palarostris* type, from the mean of *occipitalis*, is 4.04 times the standard deviation of the latter—a highly significant difference. The relative lengths of the red and black blotches in *occipitalis* are also quite different. *Palarostris* is a brilliantly colored little snake, and with its conspicuous red blotches is even more beautiful than *occipitalis*, which is admired even by persons who do not usually care for snakes.

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[2] The type of *occipitalis* from the Mohave Desert had 33 black bands.

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TRANSACTIONS

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A NEW SEA-URCHIN FROM THE "OLIGOCENE" OF OREGON[1]

BY

HUBERT LYMAN CLARK

Museum of Comparative Zoölogy, Cambridge, Mass.

INTRODUCTION

Several years ago Professor Hubert G. Schenck, of Stanford University, sent to the Museum of Comparative Zoölogy a rock fragment, collected in Oregon in 1931, bearing the mold of most of the upper surface of a large spatangoid of which he desired identification. Besides the nearly complete impression, the fragment bears portions of the molds of at least three other individuals of the same species, but these are of practically no assistance in determining the systematic position of the spatangoid involved. Recently (1936) Professor Schenck has sent an additional specimen of what he thinks is the same species, but from a different locality —State of Washington, and has asked for a name by which these echini may be designated.

There is no doubt that the molds in the earlier specimen represent more or less of the petaloid areas of a species of *Brisaster,* very similar to, but probably not identical with, the Recent species, *B. townsendi* (A. Ag.), which occurs along the whole western coast of North America in water of moderate (511-995 fathoms) depth. The apical system of the fossil is much more anterior than in *townsendi,* and the petals are straighter and relatively narrower. But unfortunately *townsendi* is a very variable species and not a great deal of reliance can be placed on these differences.

[1] Abstract in Geol. Soc. Am. Proc. for 1936 (1937).

In view, however, of the very much greater size of the fossil form, it may perhaps be justifiable to lay some stress on the markedly anterior apical system and distinguish the extinct species from its Recent congener under the name *maximus*. Careful comparison with a large example of *townsendi* enables one to describe this new *Brisaster* as follows:

Brisaster maximus, sp. nov.

Plate 24, fig. 9

Length about 84 mm., with the width approximately 76 mm.; nearly the whole width is shown in the large mold. If the proportions were the same as in *townsendi,* the height was about 42 mm. In the Recent species the apex is far back of the middle of the dorsal surface, so that its center is only .40 of the test length from the posterior margin of the test; in the fossil the apex is so near the center that the anterior margin could not have been more than 4 or 5 mm. further away than the rear end of the test. As a result of this difference in the position of the apex, the distal ends of petals I and V are far from the test margin in *maximus,* while in *townsendi* they nearly reach it; indeed, in some specimens they would overreach it if they did not diverge markedly from each other and from the longitudinal axis. The size of the petals and the angles which they make with the axis and with each other show very great diversity in *townsendi,* but it is rare for petals I and V to form as narrow an angle with each other as they do in *maximus* (about 80°); in *townsendi* the angle commonly exceeds 90° and may be much more.

The tuberculation of the test in *maximus* was apparently very much as in *townsendi,* the larger tubercles occurring beside the petals, especially near the distal ends. Fragments of the peripetalous fasciole can be distinguished here and there, most evidently around the tip of petal V and thence anteriorly towards petal IV.

Holotype and Type Locality

The holotype of *maximus* is in the Museum of Comparative Zoölogy, Harvard University, No. 3830; a plastotype is in the Schenck Collection, Stanford University, No. 2196. Collector: John T. Holman, who describes the type locality (Holman field locality No. 44) as follows:

Washington County, Oregon, from the center of the south line of Section 12, T. 3 N., R. 4 W.; dug well along road at C. H. Bonham farm; 1000 feet south of coal seam exposure; Pittsburg Bluff formation, Refugian Stage; *Acila shumardi* zone, "Oligocene" of Pacific Slope authors.

The locality is shown on the map in the monograph by Schenck (1936, p. 43).

SPECIMEN FROM WASHINGTON

The specimen sent by Professor Schenck in 1936 comes from "Loc. N. P. 55,[2] near Porter, Washington," H. Hannibal, collector. It consists of the upper and lower portions of a mold in a soft, clay-like, gray rock. In connection with petal IV, on the lower portion, is a small part of the test with many minute spines still present, while on the upper portion a large part of the peripetalous fasciole can be made out. The specimen was badly crushed before fossilization and its normal size and proportions are therefore uncertain. Apparently it was 60-65 mm. long and 50-55 mm. wide. While it seems unquestionably a *Brisaster,* there are some features of the petals I and V that are unlike *maximus* and make it possible to have some doubts as to its identity with the Oregon specimens, in spite of Professor Schenck's opinion (presumably on stratigraphical grounds) that "it must belong to the same species." But in view of the great diversity shown by individuals of *townsendi,* it seems foolish to doubt that the Oregon and Washington fossils represent the same species of *Brisaster,* since their geological position is essentially the same. Whether *maximus* is the direct forerunner of *townsendi* is a matter that admits of more uncertainty.

THE GENUS BRISASTER

The genus *Brisaster* was named by Gray (Cat. Rec. Ech. Brit. Mus., p. 61, 1855) as a subgenus of *Schizaster* with three species; *fragilis, gibberulus,* and *cubensis.* The year before, d'Orbigny (Pal. France Crét., p. 270, 1854) had placed *cubensis* in the genus *Periaster.* In 1883, Pomel (Class. Méth. Ech., p. 36) made *gibberulus* the type of the genus *Paraster.* Thus, *Schizaster fragilis* Agassiz and Desor, 1847, alone is left to be the type of *Brisaster.*

A. Agassiz, Duncan, and W. B. Clark and Twitchell never recognized *Brisaster,* but treated it as a synonym of *Schizaster.* However, Mortensen (Ingolf Ech. pt. 2, pp. 122-123, 1907) discussed the genus *Schizaster,* recognizing four subgenera: *Paraster, Schizaster,* s.s., *Tripylaster,* and *Brisaster.* H. L. Clark (Mem. Mus. Comp. Zoöl., vol. 46, no. 2, pp. 159 et seq., 1917) accepted Mortensen's four biologic units as valid

[2] Professor Schenck informs me that the initials stand for "North Pacific" and that the number is H. Hannibal field locality No. 55.

genera, and included six Recent species in *Brisaster*, two of which (*latifrons* and *townsendi*), occur in the eastern and northern Pacific Ocean. In short, there can be no doubt that *Brisaster* is a valid nomenclatural unit.

The species of *Schizaster* and *Brisaster* are distinguished by three characters, as follows:

1. Test relatively high and more or less swollen in *Schizaster*, especially posteriorly; more flattened and widened in *Brisaster*.

2. Genital pores: two in *Schizaster*, three in *Brisaster*.

3. In *Schizaster*, petals II and IV are short, wide, divergent; petal III deeply sunken, but usually not very broad. In *Brisaster*, petals II and IV are long, comparatively narrow, directed well forward, sometimes so markedly so as to be nearly parallel for a short distance; petal III somewhat sunken, broad.

The time range of *Brisaster* is given commonly as Eocene to Recent, as may well be. Lambert and Thiéry, for example, list a number of species of *Brisaster* which they assign to the Eocene. There is not one that can unqualifiedly be called *Brisaster*, although *Schizaster pyrenaicus* Munier-Chalmas is a likely candidate.

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Explanation of Plate

Figs. 1-6. *Brisaster fragilis* (Agassiz and Desor), x 3/4.

Recent. Hypotype No. 6064, (Stanford University Paleo. Type Coll.). Off east coast of the United States, 140-216 fathoms. Length of specimen 49.2 mm., width 46.8, thickness 30.8.

Figs. 7-8. *Brisaster latifrons* (Agassiz), x 4/5.

Recent. Eastern Pacific, "Albatross" station 3431, 995 fathoms. (Copy of protographs).

Fig. 9. *Brisaster maximus* H. L. Clark, n. sp., x 2/3.

Holotype No. 3830, (Museum of Comparative Zoölogy, Harvard University). From Washington County, Oregon, Sec. 12, T. 3 N., R. 4 W. "Oligocene."

Figs. 10-12. *Brisaster townsendi* (Agassiz). Recent. Eastern Pacific.

Figs. 10-11, x 4/5. Hypotype No. 6949, (Calif. Acad. Sci. Loc. 28046). Howe Sound, British Columbia. Collector, S. A. Glassell. Length, 50.4 mm., thickness 26.8 mm.

Fig. 12, x 4/5. Hypotype No. 6950, (Calif. Acad. Sci. Loc. 28046). Howe Sound, British Columbia. Length, 56.5 mm. (Photographs of this species by Frank L. Rogers, W. P. A. project).

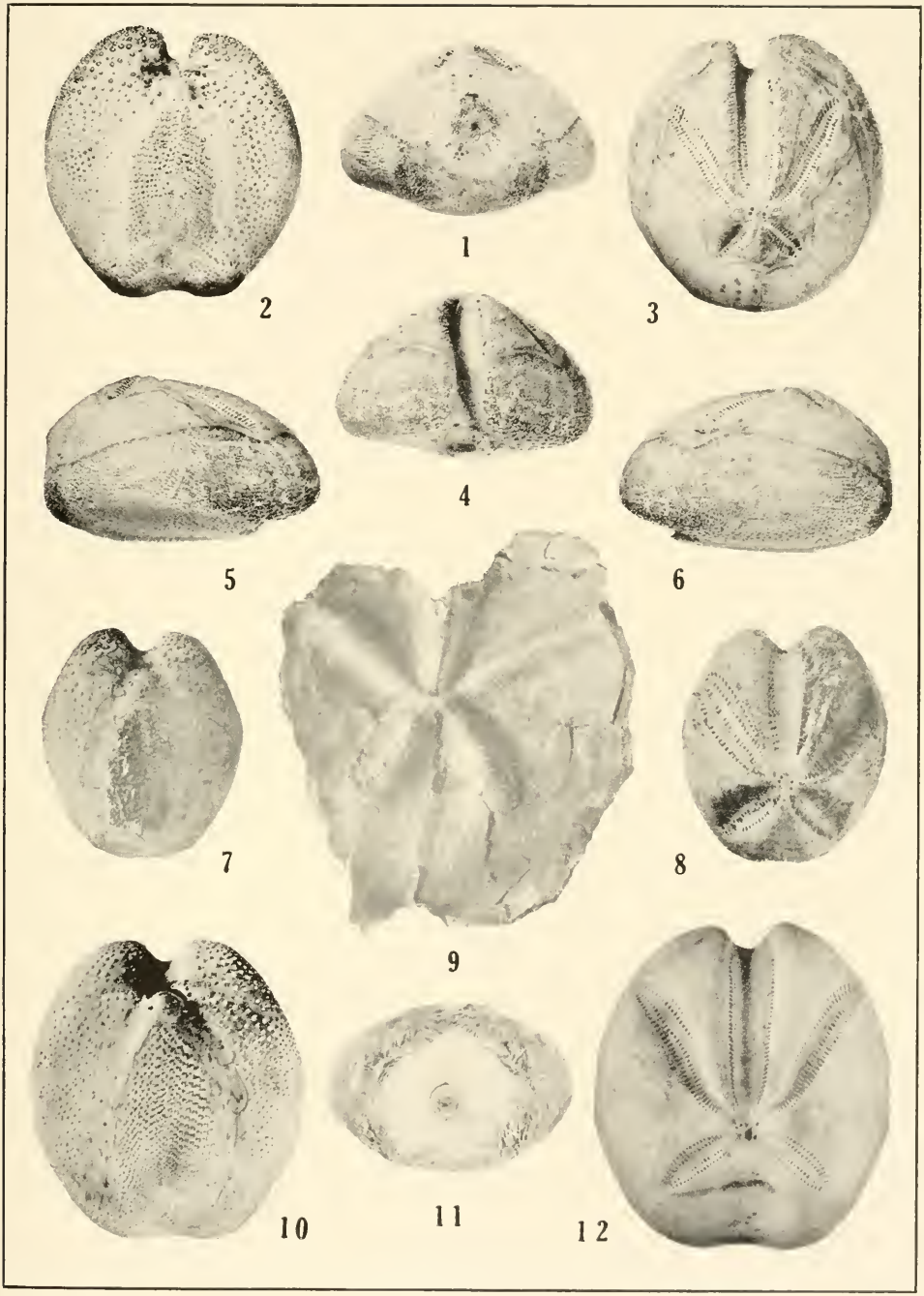
Figs. 3, 8, and 12 are views of the upper surface.

Figs. 2, 7, and 10 are views of the lower surface.

Figs. 1 and 11 are views of the rear end.

Figs. 5 and 6 are side views.

Fig. 4 is an anterior end view.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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

Vol. VIII, No. 29, pp. 375-378, text figs. 1, 2 December 15, 1937

AN EXTINCT PUFFIN FROM THE PLIOCENE OF SAN DIEGO, CALIFORNIA

BY

Loye Miller

Professor of Biology, University of California at Los Angeles

Through the very great courtesy of Director Clinton G. Abbott and Mr. Frank Gander of the museum of the San Diego Society of Natural History, I have lately come into possession of an interesting bird femur from the San Diego Pliocene. The specimen was collected by Mr. Gander's son from an exposure of marine gravels on Market Street near Euclid Avenue in the eastern part of the city of San Diego. This formation and this same locality yielded, five years ago, the second known specimen of *Mancalla californiensis* Lucas (Miller, L., 'Condor,' XXXV, pp. 34-35, Jan., 1933). Dr. U. S. Grant has made some study of the invertebrate fauna of these beds with the conclusion that they are of Upper Middle Pliocene age, well above the middle of the San Diegan formation.

The matrix is fine grained, gray sand of quite uniform texture. Enough motion had taken place prior to the entombment of the specimen to wear away the more delicate contours, a fact that would indicate that relatively shallow and active water had deposited the stratum.

The bone has been extensively mineralized without appreciable staining. A clean fracture of the shaft shows a central cavity that seems, at first impression, rather small for a bird bone. However, the diving birds do not have such large shaft cavities in their bones, especially in the femur. In the femur of the loon, the cavity is almost rendered nil by the abundant cross struts of dense bony tissue. In the fossil specimens such struts are

not found at the point of fracture. In those highly specialized divers, the loons and grebes, that depend mainly upon the feet for underwater progress, the femur tends toward a short, thick, and strongly curved form.

The puffins, on the other hand, have relatively weak feet. In rapid underwater progress, their wings are brought into play in a true underwater flight. The pelvic limb is less specialized and the long, slender femur does not differ radically from that of their surface feeding relatives, the gulls. The fossil femur here discussed is of this latter type. It is about the size of that of the Herring Gull from which it differs as would a living puffin. The trochanter is less developed, there is a slightly greater dorsiventral curvature and a much greater lateral arching. *Anhinga, Sula,* the cormorants, and the diving anserines are entirely different. The fossil is most closely like the puffins of the genus *Lunda,* from which it differs in certain details as well as in its much greater size. There seems to be no genus of the living Alcidae to which the specimen may properly be referred. It is therefore deemed necessary to establish a new genus for which the name *Pliolunda* is proposed.

Pliolunda diegense, new gen. and sp.

Type.—Right femur, No. 33409, Museum of Paleontology, University of California; from the Upper Middle Pliocene, San Diegan formation.

Most closely like *Lunda cirrhata* in general appearance, curvature of shaft, and axes of the articulations. Size much greater; trochanteric ridge less prolonged down the shaft; obturator ridge more pronounced; popliteal area more depressed; rotular groove slightly wider; external condyle more prolonged and inner condyle less prolonged up the anterior face of the shaft.

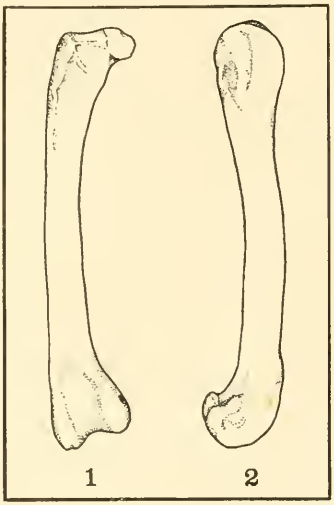
These differences are sufficiently pronounced to prevent assignment to the genus *Lunda,* but they are not considered to be fundamental, nor do they appear to be correlated with adaptive differences. The femur of the Great Auk (*Plautus impennis*) has much the same characters of the distal end, but is not so closely like it proximally. *Plautus* might properly be considered as the extreme of specialization among the Recent alcids, but this specialization is not reflected in the femur. The Lucas Auk (*Mancalla californiensis*) from the same formation is almost as large as the Great Auk, hence the specimen here discussed could not be properly considered of that species, the femur of which is not known. It does appear, however, as a contemporary of the Lucas Auk, and it may have had similar habits.

Remarks.—The present day metropolis of the puffins and their nearer allies is well to the northward of San Diego. During the later stages of Pliocene time there were accumulated at a number of stations along the Southern California coast quite extensive molluscan faunas, some species of which serve as temperature indicators of fairly definite nature.

According to Grant and Gale (Mem. San Diego Soc. Nat. Hist., Vol. I, 1931, p. 35), the San Diegan formation begins with a fairly warm water fauna which changes definitely to a cool water fauna toward its close so that Upper Pliocene is found to contain "numerous specimens of species that live today between Alaska and Puget Sound." Into such a picture of advancing cold, this new species of Pliocene puffin would fit quite harmoniously.

Measurements—Measurements of type specimen of *Pliolunda* are as follows:

Length from trochanter to outer condyle	55.7 mm.
Least shaft diameter	4.5 mm.
Transverse diameter through condyles	10.8 mm.



Figs. 1, 2. Anterior and external views of the type specimen *Pliolunda diegense*, approximately natural size.

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TRANSACTIONS

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SAN DIEGO SOCIETY OF NATURAL HISTORY

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AN UPPER PLEISTOCENE FAUNA FROM THE BALDWIN HILLS, LOS ANGELES COUNTY, CALIFORNIA

BY

GEORGE WILLETT

Los Angeles Museum

SAN DIEGO, CALIFORNIA

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AN UPPER PLEISTOCENE FAUNA FROM THE BALDWIN HILLS, LOS ANGELES COUNTY, CALIFORNIA

BY

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Los Angeles Museum

In 1926 Professor A. J. Tieje (Bull. Am. Assoc. Petr. Geol., Vol. 10, p. 510), in a discussion of the Pliocene and Pleistocene history of the Baldwin Hills, referred to a warm water fauna uncovered in Trench 6 of the Los Angeles Outfall Sewer, giving it the name of the Centinela Gravels. A much more extensive exposure of what is apparently the same fauna occurred a few years later during the widening of Lincoln Avenue, which crosses the outfall sewer about two miles northeast of Playa del Rey. At a point just south of the sewer, at an altitude of about fifty feet above sea level, excavations by steam shovels cut into the upper part of the fossiliferous strata, exposing large numbers of marine invertebrates.

During the summer of 1935 a number of lots of fossil shells from this section were brought to me for identification, and, after studying them, I became sufficiently interested in certain features of the collections to undertake a rather careful examination of the locality from whence they came.

The fossiliferous stratum, from eight to twelve inches thick in most places, was found to be mainly from two to four feet below the present surface. It was bordered, both above and below, by sand which sometimes contained sparsely scattered, small, water-worn stones. In some sections there was a thin stratum of echinoderms a few inches above the mollusk-bearing vein, but this was by no means constant.

During 1935 and 1936 I made many trips to this fossil locality, and excavated, screened and carefully examined several tons of material. This resulted in an accumulation in the Los Angeles Museum of more than 30,000 specimens. While the majority of these are mollusks, several other groups were well represented. No attempt was made to preserve all the specimens uncovered, in the case of the more common species only a good representation being kept, and all badly worn or broken specimens being discarded except in case of the rarer species. A million would probably be

a conservative estimate of the total number of specimens examined.

In addition to the above, I have had access to the collections of John Q. and Tom Burch, Alex Clark, Mr. and Mrs. Philip M. Connelly, Miss Edna T. Cook, Mrs. Bertha M. Fuller, Steve A. Glassell, J. C. Marsh, Miss Alice Waterbury, and H. C. and Homer L. White, all of whom possess considerable material from the Del Rey deposits. To these friends, who have not only allowed free use of their collections, but have donated numerous specimens to the Los Angeles Museum, my sincere thanks are due. I am also indebted to the following students for classifying material in their respective fields: Steve A. Glassell, decapod crustaceans; Dr. U. S. Grant, echinoderms; Dr. Howard R. Hill, barnacles and bryozoans; and Dr. Hildegarde Howard, birds. Finally my gratitude is expressed to Dr. U. S. Grant and A. M. Strong for helpful information regarding literature and taxonomic questions.

Among the more striking features of this deposit are the abundance of crustacean remains, the great number of specimens of small mollusks, such as Pyramidellids, Melanellids and Turrids, and the periodic purity of the entire assemblage; that is, it may be almost entirely attributed to one distinct and rather exact period. There has apparently been very little mixing of materials from different geological ages, as is so common in many of our coastal fossil deposits. That this horizon is the same as Professor Tieje's "Centinela Gravels" is indicated, not only by locality, but by comparison with a list of fifty-five species of mollusks in an unpublished manuscript of Professor Tieje.

From a study of the nature of the marine fauna of this section, it would appear that its habitat was sandy ocean bottom, at a depth of from ten to twelve fathoms, near the mouth of a bay or slough, the latter feature being indicated by the presence of a few examples of marsh species such as *Melampus, Helisoma* and *Gyraulus,* which must have drifted down from coastal marshes.

A summary of the material preserved is as follows. Of mammals there are the remains of two species, a seal, and a dolphin or porpoise, that we have not identified more closely up to the present. According to Dr. Hildegarde Howard, ten species of birds are represented, two being extinct and the other eight apparently Recent. One of the fossil species is *Chendytes lawi,* a very large diving duck, first described by Dr. Loye Miller from the Upper San Pedro formation of Santa Monica Canyon. The other fossil bird is a hitherto undescribed gannet, of the genus *Moris,*

this genus being previously known on the Pacific coast by only one species, from the Miocene of Kern County. In the 'Condor' (vol. 38, 1936, p. 213) Dr. Howard has named this gannet *Moris reyana* and has given a detailed account of the avian remains found in this deposit.

There is a goodly representation of fish material, more than 700 specimens being preserved, but we have, as yet, not found any ichthyologist who can give the time necessary to identify all of the elements. Teeth of at least two species of sharks are rather common, and teeth and stingers of rays are even more so. There are also teeth of a sheephead, and many ear bones, vertebrae and other elements unidentified as yet.

Echinoderms were abundant, but very fragile, and perfect specimens difficult to obtain. According to Dr. U. S. Grant, the following are represented: *Strongylocentrotus* sp. ?., *Lovenia cardiformis* A. Agassiz, and *Dendraster* sp. nov. The latter species is known only from late Pleistocene, the others being found living in this same latitude today. The Round Bryozoa, *Lichenopora radiata* (Audouin), the only member of the group found, was abundant and usually well preserved. The barnacles, identified by Dr. Howard R. Hill, are of three species. The Pink Barnacle, *Balanus tintinnabulum californicus* Pilsbry, was abundant; two specimens of *Tetraclita squamosa rubescens* Darwin were found, also a number of segments of the Whale Barnacle, *Coronula regina* Darwin.

The decapod crustaceans were studied by Steve A. Glassell, who reports the following species: *Callianassa longimana* Stimpson, *Dardanus arnoldi* Rathbun, *Dromidia larraburei* Rathbun, *Randallia ornata* (Randall) (by far, the most abundant species), *Hepatus lineatus* Rathbun, *Heterocrypta occidentalis* (Dana) (second in numbers), *Mesorhoea idae* Rathbun, *Pyromaia tuberculata* (Lockington), *Pugettia producta* (Randall), *Pugettia richii* Dana, *Taliepus nuttallii* (Randall), *Loxorhynchus grandis* Stimpson, *Callinectes bellicosus* Stimpson, *Portunus xantusii* (Stimpson), *Cancer branneri* Rathbun, *Cancer antennarius* Stimpson, *Cancer gracilis* Dana, *Cancer anthonyi* Rathbun, *Cancer productus* Randall, *Lophopanopeus frontalis* (Rathbun), *Lophopanopeus diegensis* Rathbun, and *Cycloxanthops novemdentatus* (Lockington); also three species not yet determined, probably undescribed.

Mr. Glassell comments on this assemblage as follows: "Of the identified species, the greater per cent are living here today. Three (*Mesorhoea idae* and two species as yet unnamed) are only known as fossils, but may, like two other species (*Hepatus lineatus* and *Callinectes bellicosus*) found

in this horizon, be represented at the present time in lower latitudes. In this lot also have been found three species of our present day fauna which have not previously been reported as fossil. These are *Dromidia larraburei, Taliepus nuttallii,* and *Cancer antennarius.* A striking feature of the collection is the absence of the remains of strictly inter-tidal forms. So far, not a single specimen of these numerous species has been observed, although an occasional one might well be expected. While all of the species are not intrinsically shallow water forms (some having a bathymetric range of over fifty fathoms), still the living ones may all be taken today from the extreme minus tide line to at least the fifteen fathom contour. Due to the preponderance of fragments of one or two species (nothing but pieces remaining), it might be inferred that the balance of species in this Pleistocene deposit was not the same as the present day fauna. This, however, is probably not the case, for it is safe to assume that only those crustacean processes have survived which were structurally able to do so."

A study of the mollusks has resulted in recognition of 296 species, which divide as follows: Pelecypods, 90; Scaphopods, 5; Gastropods, 201. Five genera and forty-eight species are added to the Californian fossil list. These genera are *Ensis, Siphonodentalium, Atys, Engina* and *Simnia.* The species are *Mytilus adamsianus* Dkr., *Rochefortia reyana* sp. nov., *Bornia cooki* sp. nov., *Petricola tellimyalis* (Cpr.), *Ensis californicus* Dall, *Dentalium numerosum* Dall, *Siphonodentalium quadrifissatum* Dall, *Cavolina trispinosa* Lesueur, *Atys casta* Cpr., *Cancellaria bullata* Sby., *Engina strongi* Pils. and Lowe, *Purpura carpenteri* (Dall), *Purpura petri* (Dall), *Purpura gemma* (Dall), *Purpura santarosana* (Dall), *Thais biserialis* (Blain.), *Simnia catalinensis* (Berry), *Erato vitellina* Hinds, *Alabina tenuisculpta diegensis* Bartsch, *Cerithiopsis cosmia* Bartsch, *Cerithiopsis halia* Bartsch, *Cerithiopsis oxys* Bartsch, *Cerithiopsis antemunda* Bartsch, *Rissoella* sp. ?, *Fartulum orcutti* Dall, *Fartulum occidentale* Bartsch, *Calyptraea contorta* Cpr., *Acmaea cassis nacelloides* Dall, *Tricolia substriata* (Cpr.), *Tegula pulligo* (Mart.), *Calliostoma gloriosum* Dall, *Epitonium sawinae* Dall, *Turbonilla sanctorum* Dall and Bartsch, *Turbonilla superba* Dall and Bartsch, *Turbonilla vexativa* Dall and Bartsch, *Turbonilla antestriata* Dall and Bartsch, *Turbonilla almo* Dall and Bartsch, *Turbonilla adusta* Dall and Bartsch, *Turbonilla weldi* Dall and Bartsch, *Turbonilla ista* Bartsch, *Turbonilla canfieldi* Dall and Bartsch, *Turbonilla regina* Dall and Bartsch, *Odostomia eugena* Dall and Bartsch, *Odostomia nemo* Dall and Bartsch, *Odostomia donilla* Dall and Bartsch, *Odostomia helena* Bartsch, and *Lepidopleurus nexus* (Cpr.).

That there has been a mixing of faunas, though an exceedingly limited one, is indicated by the presence of examples of the following ten species of a colder water fauna: *Pecten hericeus* Gld., *Lora fidicula* (Gld.), *Spirotropis barbarensis* (Dall), *Spirotropis perversa* (Gabb), *Neptunea tabulata* (Baird), *Exilioidea rectirostris* (Cpr.), *Trophon orpheus* (Gld.), *Ranella oregonensis* (Redf.), *Epitonium wroblewskyi* (Mörch), and *Tegula pulligo* (Mart.). These are all Recent species, occurring at the present time either further to the northward or in deeper water in our latitude. The total number of individuals of these ten species in our collections is only seventeen, so that the true ratio of their abundance would be, not ten to 289, but seventeen to several hundred thousand, as all representatives of the cold water fauna were preserved, while the majority of warmer water forms were discarded. Most of these seventeen specimens are more or less fragmentary and all are much eroded, their appearance thus indicating greater age than that of the remainder of the fauna. There is no doubt in my mind that the few representatives of this older fauna were already fossils at the time the others were living.

These deposits have been referred to as being, for the greater part, representatives of a warm water fauna, and that the water was even less cold than it is today is indicated by the following facts. Of the 286 species (after deleting the ten older ones), 261 occur living in this latitude today, and nineteen are found, so far as we know, only further to the southward, many of them being confined to Mexican waters. These are: *Pecten vogdesi* Arnold, *Crassinella branneri* (Arnold), *Crassinella varians* (Cpr.), *Aligena cerritensis* Arnold, *Cardium procerum* Sby., *Mactra pallida* Brd. and Sby., *Dentalium numerosum* Dall, *Retusa carinata* (Cpr.), *Bulla punctulata* A. Adams, *Pseudomelatoma penicillata semiinflata* Grant and Gale, *Mangelia cetolaca* Dall, *Cancellaria bullata* Sby., *Mitra fultoni* E. A. Smith, *Cantharus fortis* (Cpr.), *Nassarius cerritensis* Arnold, *Purpura leeana* (Dall), *Thais biserialis* (Blain.), *Turbonilla sanctorum* Dall and Bartsch, and *Turbonilla superba* Dall and Bartsch. Six remaining species, *Rochefortia reyana* sp. nov., *Bornia cooki* sp. nov., *Rissoina pleistocena* Bartsch, *Delphinoidea coronadoensis* Arnold, *Epitonium clarki* T. S. Oldroyd, and *Ischnochiton sanctaemonicae* Berry are listed as extinct. However, a Recent specimen of *Epitonium clarki,* from Lower Californian waters, has been examined, and it is entirely possible, if not probable, that the other five may eventually be found living in moderate depths off Lower California, this being a region where very little shallow dredging has been done to date.

Among the interesting facts brought out by a study of the genetic relationship of the mollusks in this deposit, two features were emphasized particularly. First, in no single instance, where a sufficient amount of comparative Recent material was available, was there any perceptible difference in either form or sculpture between fossil and Recent examples of a species. Second, the accumulation of an abundant representation of some supposed species, previously known by very few specimens, indicates that many characters generally used in differentiating species are extremely inconstant, and can be considered to represent only individual variation within the species.

The literature most used in this study includes: Paleontology and Stratigraphy of San Pedro, California, by Ralph Arnold (1903); A Monograph of West American Pyramidellid Mollusks, by Dall and Bartsch (1909); Marine Shellbearing Mollusks of the Northwest Coast of America, by W. H. Dall (1921); Marine Shells of the West Coast of North America, by Mrs. Ida S. Oldroyd (1924-27), and Pliocene and Pleistocene Mollusca of California, by Grant and Gale (1931). No attempt has been made to include a complete synonymy of the species, but where the names in the above works differ from those used in this paper, they are listed as synonyms.

The following is a list of the mollusks, with remarks on some of the species. A number after the name of a species refers to the number of specimens preserved in the Los Angeles Museum, unless otherwise stated.

Nucula (Nucula) exigua Sowerby.— Syn., *Nucula suprastriata* Cpr. (Arnold, 1903).— Abundant; many still in pairs. (550 pairs, 1150 valves).

Leda taphria Dall.— Syn., *Nuculana taphria* (Dall) (Grant and Gale, 1931).— Common. (30 pairs, 120 valves).

Yoldia cooperi Gabb.— 1 fragment, including hinge, found by Miss Edna T. Cook.

Glycymeris septentrionalis (Middendorff).— Syn., *G. subobsoleta* (Cpr.): *G. barbarensis* Conr.: *G. corteziana* Dall ?.— (110 valves). I am not sure of the above synonymy, but believe it correct, with the possible exception of the last name. Shells in my collection, identified by Dr. Dall as *corteziana*, are certainly the same as the fossils, but I have not seen the type of *corteziana*. These shells differ greatly individually as regards shape, thickness and amount of sculpture.

Ostrea lurida Carpenter.— 13 valves.

Ostrea palmula Carpenter.— 1 valve.

Pecten (Hinnites) multirugosus Gale.— Syn., *Pecten giganteus* Gray (Arnold, 1903): *Hinnites giganteus* Gray (Dall, 1921; Oldroyd, 1924).— Not

very common, probably because of sandy character of locality. (7 valves).

Pecten (Chlamys) hericeus Gould.— Syn., *"Pecten hastatus* Sby." (Grant and Gale, 1931).— 2 valves in White collection.

Pecten (Aequipecten) latiauritus Conrad.— Abundant. (170 valves).

Pecten (Aequipecten) circularis Sowerby.— Syn., *P. c. aequisulcatus* Cpr. (Dall, 1921; Oldroyd, 1924).— Much less common than the last. (8 valves).

Pecten (Pecten) stearnsii diegensis Dall.— 2 right valves, 1 left valve, 25 fragments.

Pecten (Pecten) vogdesi Arnold.— Syn., *P. dentatus,* of some authors; not of J. Sowerby; *P. excavatus,* of some authors; not of Anton: *P. cataractes* Dall (Nautilus, 27, 1914, p. 121): *P. heimi* Hertlein (Proc. Calif. Acad. Sci., Ser. 4, 14, 1925, p. 9).— 1 right valve and 9 fragments; 2 valves in White collection.

Lima dehiscens Conrad.— 5 valves.

Anomia peruviana d'Orbigny.— Syn., *A. lampe* Gray (Arnold, 1903). — Upper valves common, probably having drifted in from rocky localities.

Pododesmus macroschisma (Deshayes).— Much less plentiful than *Anomia.* 2 valves taken by the writer and 1 by Mrs. Fuller.

Mytilus (Mytilus) californianus Conrad.— 1 half valve (with hinge) found by Mrs. Fuller; 1 pair in White collection.

Mytilus (Mytilus) adamsianus Dunker.— 1 valve.

Volsella modiolus (Linnaeus).— Syn., *Modiolus modiolus* Linn. (Dall, 1921; Oldroyd, 1924).— 8 valves, 12 fragments.

Volsella capax (Conrad).— Syn., *Modiolus capax* Conr. (Dall, 1921; Oldroyd, 1924).— 3 valves.

Volsella flabellata (Gould).— Syn., *Modiolus flabellatus* Gld. (Dall, 1921; Oldroyd, 1924).— 9 fragments.

Lithophaga plumula (Hanley).— 1 pair collected by Tom Burch.

Periploma planiuscula Sowerby.— Syn., *P. argentaria* Conr. (Arnold, 1903).— Hinge teeth rather common; occasional fragments of other sections of shell.

Thracia (Cyathodonta) undulata (Conrad).— Syn., *Cyathodonta dubiosa* Dall, *C. pedroana* Dall (Dall, 1921; Oldroyd, 1924).— 10 fragments.

Pandora punctata Conrad.— Syn., *Clidiophora punctata* Conr. (Arnold, 1903).— 2 pairs, 6 fragments.

Crassinella branneri (Arnold).—Syn., *Astarte branneri* (Arnold, 1903).— 180 valves.

Crassinella varians (Carpenter).— (6 pairs, 45 valves). Not listed by Grant and Gale, but recorded by Woodring (Am. Journ. Sci., 29, 1935, p. 303) from San Pedro Hills.

Glans carpenteri (Lamy).— Syn., *Lazaria subquadrata* Cpr. (Arnold,

1903): *Cardita subquadrata* Cpr. (Dall, 1921; Oldroyd, 1924): *Glans minuscula* (Grant and Gale, 1931).— 2 valves.

Chama pellucida Broderip.— 34 valves.

Lucina (Myrtea) californica Conrad.— Syn., *Phacoides californicus* Conr. (Dall, 1921; Oldroyd, 1924).— 1 valve.

Lucina (Myrtea) nuttallii Conrad.— Syn., *Phacoides nuttallii* Conr. (Dall, 1921; Oldroyd, 1924).— Abundant. (3 pairs, 85 valves).

Lucina (Myrtea) tenuisculpta approximata (Dall).— Syn., *L. tenuisculpta* Cpr. (Arnold, 1903, at least part): *Phacoides approximatus* Dall (Dall, 1921; Oldroyd, 1924).— Abundant. (375 valves). This appears to be a southern race of *L. tenuisculpta* and it is probable that Arnold's "Upper San Pedro" specimens are referable to it. Southern shells are smaller, with accentuated radial sculpture. That the two forms exist in the same latitude, as has been inferred by many authors, is perhaps doubtful.

Lucina (Here) excavata Carpenter.— Syn., *Phacoides richthofeni* Gabb (Dall, 1921; Oldroyd, 1924).— (67 valves). Gabb's *richthofeni* is undoubtedly the adult of Carpenter's *excavata*.

Taras orbellus (Gould).— Syn., *Diplodonta orbella* Gld. (Arnold, 1903; Dall, 1921; Oldroyd, 1924).— 6 valves.

Kellia suborbicularis laperousii (Deshayes).— Syn., *Chironia suborbicularis laperousii* Desh. (Grant and Gale, 1931).— This species is so fragile that it occurs mostly in fragments. However, 16 valves in fair condition are preserved. The name *laperousii* is used here solely because of the statement by Grant and Gale that Pacific coast specimens average larger than shells of the British Isles. These authors used the generic name *Chironia* with this species on the grounds that Heermannson (1847) named *Cardium* (*Lasaea*) *rubrum* Mont. as type of the genus *Kellia*. However, Winckworth (Journ. Conch., 20, 1934, p. 52) calls attention to the fact that Recluz (Revue Zool. Cuv., 7, 1844, p. 295) had previously designated *Mya suborbicularis* Mont. as the type of *Kellia*.

Aligena cerritensis Arnold.— 7 valves.

Rochefortia aleutica (Dall).— Common. (40 pairs, 220 valves).

Rochefortia reyana, sp. nov.
Plate 25, figs. 1, 2

Similar to *R. pedroana* Dall, but more equilateral, and with heavier and more elongated hinge teeth, the hinge line in the right valve occupying almost one-half of the margin of the valve. Left valve with one very small lamella immediately below the umbone, and deflected umbonal margin.

Types, right and left valves, No. 1046 L. A. Mus., taken by the writer, with thirty-six additional valves and one connected pair, in the Del Rey Pleistocene deposit. Type right valve measures, in millimeters: diam., 6.7; alt., 5.2; ant. lateral, 4; post. lateral, 3: left valve, diam., 7.6; alt., 5.9.

Bornia retifera Dall.— Like *Kellia*, this shell is very fragile and seldom found entire. It was probably more plentiful than the specimens preserved (1 pair and 21 valves) would indicate.

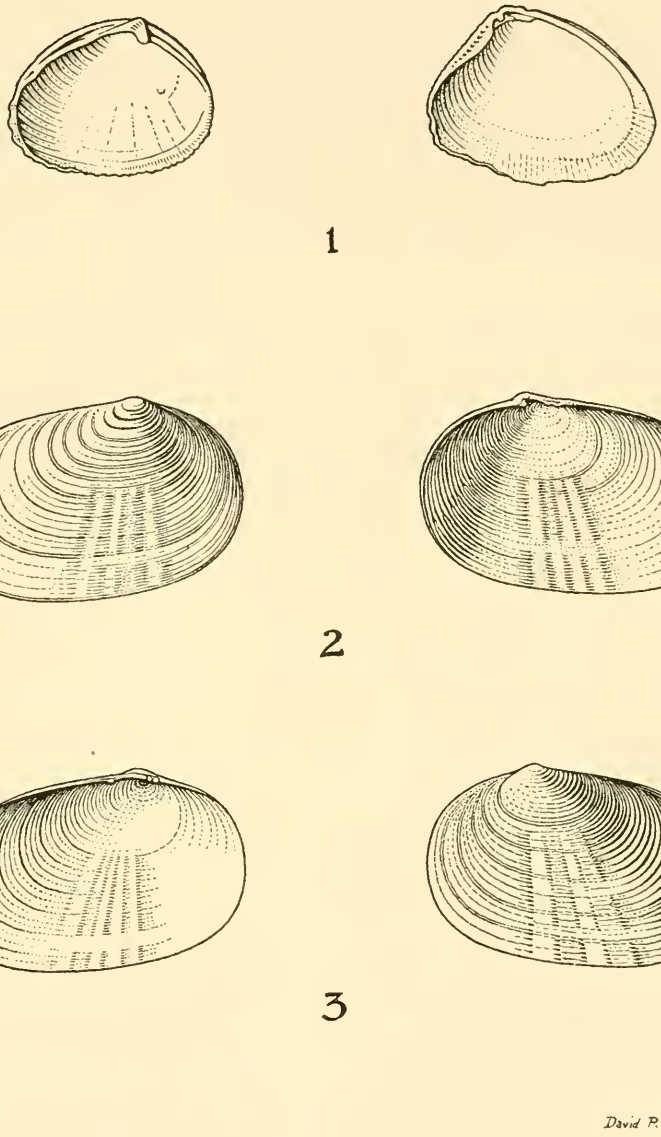

Fig. 1. *Rochefortia reyana* Willett, type, right and left valves; x 4.
Fig. 2. *Bornia cooki* Willett, type, left valve; x 4.
Fig. 3. *Bornia cooki* Willett, type, right valve; x 4.

Bornia cooki, sp. nov.
Plate 25, figs. 3-6

Shell thin, white, moderately convex, oblong, inequilateral; beaks small, distinct, situated at posterior third of shell. Surface marked by numerous concentric striations and growth lines of varying strength; also by several faint, rounded, radial ridges which start near the center of the valve and run to the ventral margin. In the type there are four of these ridges and trace of a fifth, and in the paratype, in Miss Cook's collection, the ridges are fainter but more numerous (6-7). The shagreened pattern, usual to members of the genus, is only perceptible near the margins, but it is possible that this may have been worn away on the earlier portions of the shell. Dentition similar to that of *B. retifera* Dall, but with shorter laterals and wider notch.

Type pair, No. 1047 L. A. Mus., collected, together with another right valve, by Miss Edna T. Cook, for whom it is named. The type measures, in millimeters: diam., 9.9; alt., 6.4. The paratype, in Miss Cook's collection, measures: diam., 11.4; alt., 6.8.

Except in dentition, this species is quite different from *B. retifera* Dall, the only other member of the genus found in this deposit. In its oblong, inequilateral form it is more similar to some species of the genera *Erycina*, *Montacuta* and *Sportella*, but its dentition would seem to place it with *Bornia*.

Cardium (Laevicardium) elatum Sowerby.— 8 valves; many fragments noted.

The writer prefers not to follow some recent authors who have divided this old familiar genus. He believes that the various divisions in the group may be satisfactorily indicated by using subgeneric names, as was done by Dr. Dall (1921).

Cardium (Laevicardium) substriatum Conrad.— 1 valve found.

Cardium (Laevicardium) procerum Sowerby.— Common. (60 valves).

Cardium (Laevicardium) quadragenarium Conrad.— The most plentiful species of the genus.

Cardium (Fragum) biangulatum Broderip and Sowerby.— Fairly common. (30 valves).

Venus (Antigona) fordii Yates.— 1 immature valve.

Venus (Chione) succincta Valenciennes.— Syn., *Chione undatella* Sby. (Dall, 1921; Oldroyd, 1924): *Venus neglecta* Sby., *V. simillima* Sby. (Arnold, 1903).— 21 valves.

Venus (Chione) fluctifraga Sowerby.— 3 valves.

Venerupis (Callithaca) tenerrima (Carpenter).— Syn., *Tapes tenerrima* Cpr. (Arnold, 1903): *Paphia tenerrima* Cpr. (Dall, 1921; Oldroyd, 1924).— Fairly common, but usually broken. (2 pairs, 4 hinges).

Venerupis (Protothaca) staminea (Conrad).— Syn., *Tapes staminea* Conr. (Arnold, 1903): *Paphia staminea* Conr. (Dall, 1921; Oldroyd, 1924).— Less plentiful than the last. (3 valves, 2 fragments).

Compsomyax subdiaphana (Carpenter).— Syn., *Callista subdiaphana* Cpr. (Arnold, 1903): *Marcia subdiaphana* Cpr. (Dall 1921; Oldroyd, 1924): *Clementia subdiaphana* Cpr. (Grant and Gale, 1931).— (2 valves). Dr. U. S. Grant informs me that he now considers this species generically different from *Clementia.*

Transenella tantilla (Gould).— Syn., *Psephis tantilla* Gld. (Arnold, 1903).— 5 valves.

Tivela (Pachydesma) stultorum (Mawe).— Syn., *T. crassatelloides* Conr. (Arnold, 1903).— (2 valves). There appears to be some doubt whether Mawe's *Donax stultorum*, stated to be from "Indian Seas," is really the same as this species, though his figure shows a similar shell. Possibly Conrad's name *crassatelloides* should be revived.

Saxidomus nuttalli Conrad.— Syn., *S. aratus* Gld. (Arnold, 1903).— 1 valve.

Pitar newcombianus (Gabb).— Syn., *Callista newcombiana* Gabb (Arnold, 1903): *Pitaria newcombiana* Gabb (Dall, 1921; Oldroyd, 1924).— 1 valve.

Amiantis callosa (Conrad).— Syn., *Callista callosa* Conr. (Arnold, 1903).— Abundant.

Petricola tellimyalis (Carpenter).— 70 valves.

Petricola californiensis Pilsbry and Lowe.— Syn., *P. denticulata* Sby. (Arnold, 1903; Dall, 1921; Oldroyd, 1924; Grant and Gale, 1931).— 2 valves.

Petricola carditoides (Conrad).— 1 valve collected by Miss Edna Cook.

Cooperella subdiaphana Carpenter.— 4 valves (three in Miss Cook's collection).

Tellina idae Dall.— Common. (10 pairs, 26 valves).

Tellina buttoni Dall.— 3 valves.

Tellina bodegensis Hinds.— 8 valves.

Tellina santarosae Dall.— 3 valves.

Apolymetis biangulata (Carpenter).— Syn., *Metis alta* Conr. (Arnold, 1903; Dall, 1921; Oldroyd, 1924).— Common. (5 pairs, 2 valves).

Macoma nasuta (Conrad).— 5 valves.

Macoma yoldiformis Carpenter.— 6 pairs, 22 valves.

Macoma secta (Conrad).— Common. (15 valves).

Macoma indentata Carpenter.— Syn., *M. i. tenuirostris* Dall (Dall, 1921; Oldroyd, 1924).— Abundant. (5 pairs, 40 valves).

Semele decisa (Conrad.)— 1 fragment found by the writer, another by Miss Cook.

Semele pulchra (Sowerby).— 7 valves.

Donax californicus Conrad.— 1 valve; 2 valves in Miss Cook's collection.

Donax gouldii Dall.— Syn., *D. laevigata* Desh. (Arnold, 1903).—

Abundant. (30 valves).

Gari edentula (Gabb).— Syn., *Psammobia edentula* Gabb (Arnold, 1903; Dall, 1921; Oldroyd, 1924).— 3 fragments, with hinges.

Tagelus californianus (Conrad).— 1 fragment, with hinge.

Tagelus subteres (Conrad).— 1 valve.

Solen sicarius Gould.— 20 fragments, with hinges.

Ensis californicus Dall.— 24 valves.

Siliqua lucida (Conrad).— 1 valve, 7 hinges.

Mactra (Mactra) californica Conrad.— Common. (23 valves).

Mactra (Spisula) planulata Conrad.— Syn., "*Mactra falcata* Gld." (Arnold, 1903): *Spisula planulata* Conr. (Dall, 1921; Oldroyd, 1924).— Abundant. (1 pair, 50 valves).

Mactra (Spisula) hemphilli Dall.— Common. (3 pairs, 21 valves).

Mactra (Spisula) catilliformis (Conrad).— 1 valve.

Mactra (Mulinia) pallida modesta (Dall).— Syn., "*Mactra exoleta* Gray" (Arnold, 1903).— Rather common. (3 pairs, 45 valves).

Schizothaerus nuttallii (Conrad).— Syn., *Tresus nuttalli* Conr. (Arnold, 1903).— Not rare, but mostly fragmentary. (2 pairs).

Cryptomya californica (Conrad).— Abundant. (8 pairs, 60 valves).

Corbula (Lentidium) luteola Carpenter.— Abundant; pairs of connected valves common. (250 pairs, 100 valves).

Panope (Panope) generosa Gould.— Syn., *Panopea generosa* Gld. (Arnold, 1903; Oldroyd, 1924).— Fairly common. (1 pair, 6 valves, 5 hinges).

Saxicava arctica (Linnaeus).— 1 valve.

Pholas pilsbryi Lowe.— Syn., *Zirphaea gabbi* Tryon (Arnold, 1903; Dall, 1921; Oldroyd, 1924): *Pholas gabbi* Tryon (Grant and Gale, 1931).— 1 valve, 1 fragment.

Pholadidea (Pholadidea) penita (Conrad).— 1 pair.

Dentalium neohexagonum Sharp and Pilsbry.— Syn., *Dentalium pseudohexagonum* Dall (Arnold, 1903).— Abundant. (700).

Dentalium numerosum Dall.— Six specimens seem referable to this species. In addition to these are numerous examples, referred to *neohexagonum*, that have more ribs than the typical of that form and, although complete intergradation between *neohexagonum* and *numerosum* is not shown in our series, rather close relationship between the two appears to be indicated.

Dentalium semipolitum Broderip and Sowerby.— 58 specimens, mostly more or less fragmentary.

Siphonodentalium quadrifissatum Dall.— 17 specimens.

Cadulus fusiformis Pilsbry and Sharp.— Abundant. (1300). Considering the abundance of this species in a deposit so near those worked by Arnold, it is difficult to understand why he did not find it. Pilsbry (Nautilus, 17, 1904, p. 108) believed Arnold's figure of "*Cadulus nitentior* Cpr." to be "probably of a

serpuloid annelid," but, if possible, this should be checked by a study of Arnold's material. There is some variation in this species in both shape and diameter, and Arnold's figure may represent a worn *Cadulus*.

Cavolina telemus tricuspida (Rivers).— Syn. *Cavolina occidentalis* Dall (Dall, 1921; Oldroyd, 1927).— 1 specimen collected by Miss Edna T. Cook.

Cavolina trispinosa Lesueur.— 1 in Museum collection and 3 in collection of Miss Cook.

Acteon (Acteon) traski Stearns.— Rather common, though usually broken. (225).

Acteon (Rictaxis) punctocaelatus (Carpenter).— 38.

Retusa (Acteocina) culcitella (Gould).— Syn., *Tornatina culcitella* Gld., *T. cerealis* Gld. (Arnold, 1903): *Acteocina culcitella* Gld. (Dall, 1921; Oldroyd, 1927): *Acteocina pedroensis* T. S. Oldroyd (Proc. U. S. Nat. Mus., 65, 1925, art. 22, pp. 23, 24).— Common. (600).

Retusa (Acteocina) carinata (Carpenter).

Retusa (Acteocina) inculta (Gould).— More than 600 specimens of the short, blunt-spired Retusas were preserved. While the majority of these appear referable to *carinata*, a few are indistinguishable from *inculta* and others are variously intermediate between the two. A sufficient number of Recent specimens will probably show that *carinata* and *inculta* are not more than subspecifically distinct, the former being a southern form and the latter a more northern one of the same species.

Volvulella cylindrica (Carpenter).— Syn., *Volvula cylindrica* Cpr. (Arnold, 1903).— (700). A careful examination of this splendid series shows much variation in size, length of spire, and amount of spiral sculpture. It is probable that some other named species are only variants of *cylindrica*.

Atys casta Carpenter.— 1 juvenile specimen.

Cylichna attonsa Carpenter.— Syn., *Cylichna alba* Brown (Arnold, 1903, at least part): *Cylichnella attonsa* Cpr. (Dall, 1921; Oldroyd, 1927).— (1000). Although there is considerable variation in this series, it seems advisable to refer them all to the above species, of which many are typical. Some specimens approach *C. diegensis* Dall, which may be the same as *C. propinqua* Smith. None appears referable to *C. alba* Brown, which name, in the past, has been used for most southern Californian fossils. This latter species is probably confined to northern waters and, if it has appeared at all as a fossil in southern California, it should be only in a cold water fauna.

Bulla punctulata A. Adams.— Syn., *Bullus punctulatus* (A. Ad.) (Grant and Gale, 1931).— (62). Our specimens assigned to this species differ from available Lower Californian examples in larger size (largest, 48x33 mm.), slightly more globular form, and fewer (3-6) spirals in the umbilicus. This is probably the shell that Pilsbry (Man. Conch., 15, 1893, p. 341) refers doubtfully to *B. aspersa* A. Adams. The difference in number of spirals in the umbilicus does not appear to coincide with different localities, as both types are present in specimens from the west coast of South America in the H. N. Lowe

collection. For use of *Bulla* instead of *Bullus*, see Pilsbry, Nautilus, 44, 1931, p. 98.

Haminoea vesicula (Gould).— 1 juvenile.

Melampus olivaceous Carpenter.— (14). These undoubtedly washed down from coastal marshes.

Williamia peltoides (Carpenter).— (26). The species represented is the one with elevated apex. Whether the above name is correctly applied here may be open to question (see Grant and Gale, 1931, p. 464).

Terebra (Strioterebrum) pedroana Dall.— Syn., *T. simplex* Cpr. (Arnold, 1903): *T. pedroana philippiana* Dall (Dall, 1921; Oldroyd, 1927).— (260). Abundant. The typical and the variant named *philippiana* both present.

Conus californicus Hinds.— Rather common. (16).

Megasurcula remondii (Gabb).— Syn., *Cryptoconus stearnsianus* Raymond (Dall, 1921; Oldroyd, 1927): *Surculites remondii* (Gabb) (Grant and Gale, 1931).— 41.

Megasurcula carpenteriana (Gabb).— Syn., *Pleurotoma carpenteriana* Gabb, *P. tryoniana* Gabb (Arnold, 1903): *Cryptoconus carpenterianus* Gabb, *C. tryonianus* Gabb, *C. tremperianus* Dall (Dall, 1921; Oldroyd, 1927): *Surculites carpenterianus* (Gabb) (Grant and Gale, 1931).— (130). A common and very variable species.

Lora fidicula (Gould).— Syn., *Bela fidicula* Gld. (Arnold, 1903, part): "*Lora viridula* Fabr." (Grant and Gale, 1931).— 1 specimen collected by Miss Edna T. Cook.

Spirotropis (Borsonella) barbarensis (Dall).— Syn., *Borsonella barbarensis* Dall (Dall, 1921; Oldroyd, 1927): "*Borsonella dalli* Arnold" (Dall, 1921, part; Oldroyd, 1927, part).— 1 specimen in Museum collection and another in collection of Mrs. E. M. Clark.

Spirotropis (Antiplanes) perversa (Gabb).— Syn., *Pleurotoma perversa* Gabb (Arnold, 1903): *Antiplanes perversa* Gabb (Dall, 1921; Oldroyd, 1927).— 8 specimens, all much worn and few entire. Evidently of an older fauna than the bulk of the deposit.

The writer cannot follow Grant and Gale in relegating such species as *rotula, santarosana* and *catalinae* to the synonymy of *perversa*. They appear to have not only different forms, but different ranges.

Moniliopsis incisa fancherae (Dall).— Syn., "*Drillia inermis* Hds." (Arnold, 1903): *Clathrodrillia halcyonis* Dall (Dall, 1921; Oldroyd, 1927).— Abundant. (150).

Moniliopsis incisa ophioderma (Dall).— Syn., "*Drillia inermis penicillata* Cpr." (Arnold, 1903): "*Moniliopsis incisa* Cpr." (Dall, Proc. U. S. Nat. Mus., 56, 1919, pl. 12, fig. 7; Oldroyd, 1927, pl. 18, fig. 3).— (10). Much less common than the last.

There has been much confusion among authors regarding the names to be applied to the varieties of this well known species. It would seem that the correct application of names depends entirely upon the identity of Carpenter's type of *incisa*, which does not appear to be definitely established. The arrangement here

used is based on the assumption that typical *incisa* is the northern form with "grooved" spirals and axial sculpture confined to faint growth lines. This is the shell figured by Grant and Gale (1931, pl. 26, fig. 21) as the "typical variety," but is not the same as some of the forms included in their synonymy.

The fact is that we have in southern California, both fossil and Recent, two common varieties of *M. incisa*, each of which has been referred to by several names. One type (*fancherae*, as used here) is more slender, with rounder body whorl, and sharper spiral sculpture, and is a dredged shell. The other (*ophioderma*), frequently collected at low tide, is characterized by greater diameter, more or less flattened body whorl, less sharp spiral sculpture, and (in life) vertical reddish lines. Dall's figures of both *incisa* and *ophioderma* (Proc. U. S. Nat. Mus., 56, 1919, pl. 12, figs. 5 and 7) appear to be of this latter form. *M. rhines* Dall (*cancellata* Cpr.) is probably a color form of *fancherae*, Carpenter's description calling for a white shell. Such specimens are in the writer's collection from Catalina Island.

Clavus (Cymatosyrinx) empyrosia (Dall).— Syn., "*C. pallidus* Sby." (Grant and Gale, 1931, part).— 1.

Clavus (Cymatosyrinx) halocydne (Dall).—Syn., "*C. pallidus* Sby." (Grant and Gale, 1931, part).— (3). Although Grant and Gale place this and the last species in the synonymy of *C. pallidus* (Sby.), the writer does not consider such action justified. A comparison of *halocydne* and *pallidus* shows that the latter is larger and relatively wider, and has a much heavier callus on the inner lip and a narrower constricted area at the suture. In *halocydne* this constriction, on all whorls but the last, is almost as wide as the remainder of the whorl. Furthermore, the color of *halocydne* is not white like *pallidus*, but light brown, darker in the aperture. *C. empyrosia* differs from *halocydne* and *pallidus* in both size and sculpture.

Clavus (Cymatosyrinx) hemphilli (Stearns).— Syn., *Drillia hemphilli* Sts. (Arnold, 1903): *Cymatosyrinx hemphilli* Sts. (Dall, 1921; Oldroyd, 1927): *C. aeolia* Dall (Proc. U. S. Nat. Mus., 56, 1919, p. 11).— (16). All are of the ribbed form called *aeolia* by Dr. Dall. A fine series of topotypes of *hemphilli* collected by Mr. and Mrs. P. M. Connelly at Todos Santos Bay, Lower California, are mostly quite different, both in sculpture and color, from Los Angeles County specimens of "*aeolia*," but enough intergrades have been examined to show that the two are conspecific. It is possible that *aeolia* may be a geographical race of *hemphilli*, but this remains to be demonstrated.

Clavus (Crassispira) montereyensis (Stearns).— Syn., *Crassispira arsinoë* Dall (Proc. U. S. Nat. Mus., 56, 1919, p. 26).— 1 specimen found by Miss Alice Waterbury and donated to the Museum.

Mangelia (Mangelia) hexagona Gabb.— Syn., *Mangilia branneri* Arnold (Arnold, 1903; Dall, 1921).— 7.

Mangelia (Mangelia) merita (Hinds).— 1.

Mangelia (Bela) variegata Carpenter.— Syn., *M. angulata* Cpr., not Reeve (Arnold, 1903; Dall, 1921): *M. oenoa* Dall, *M. pulchrior* Dall, *M. beta* Dall (Dall, 1921; Oldroyd, 1927): *M. barbarensis* Oldroyd (1927): "*M. hecetae* Dall and Bartsch" (Grant and Gale, 1931).— (1800). Our specimens of

this species exhibit every variation between typical *variegata* and the other forms listed in the above synonymy. Plate 26, fig. 1, shows intergradation between the two extremes, typical *variegata* on the one hand, and the angulated variety on the other. That this intergradation also occurs at the present time is indicated by specimens in the writer's collection. While, as Grant and Gale point out (1931, p. 593), the shell of *M. hecetae* Dall is indistinguishable from some specimens of the angulated form of *variegata*, an example of *hecetae* in the writer's collection, taken in southeastern Alaska, possesses an operculum, which, according to our present understanding, would place it in the genus *Lora*.

Mangelia (Bela) cetolaca Dall.— Syn., *Columbella* (*Aesopus*) *oldroydi* (Arnold, 1903, p. 238), not *Mangilia oldroydi* (Arnold, 1903, p. 213): "*Mangelia perattenuata* Dall" (Grant and Gale, 1931).— (720). Grant and Gale considered *M. perattenuata* Dall, *Philbertia phylira* Dall, and *P. amyela* Dall identical with this species. However, an examination of our large series does not appear to substantiate their views. *Perattenuata* seems more tapering than *cetolaca*, with sutures far too narrow, and with the last whorl longer than the rest of the shell, which is not the case in specimens of *cetolaca* the same size as the type of *perattenuata*. *Philbertia phylira* has fewer and more regularly spaced spiral cords than *M. cetolaca*, and *Philbertia amyela* has too few axials.

Mangelia (Bela) arteaga roperi Dall.— Syn., "*Mangilia sculpturata* Dall" (Arnold, 1903).— (360). Our specimens are uniformly more slender than examples of the typical form. It is probable that *roperi* is a southern race and that typical *arteaga* does not range as far southward as has been generally believed.

Cancellaria bullata Sowerby.— Rather rare. 1 specimen in the Museum collection, and 3 in the White collection.

Cancellaria crawfordiana Dall.— 2 specimens found, one by the writer and the other by Mrs. E. M. Clark.

Cancellaria cooperi Gabb.— 1 broken specimen.

Olivella biplicata (Sowerby).— Common. (76).

Olivella baetica Carpenter.— Abundant. (170).

Hyalina (Cypraeolina) pyriformis (Carpenter).— Syn., *Merovia pyriformis* Cpr. (Dall, 1921): *Cypraeolina pyriformis* Cpr. (Oldroyd, 1927).— 1 specimen collected by Mrs. Clark.

Mitra idae Melvill.— Syn., "*Mitra maura* Swain." (Arnold, 1903): *Strigatella idae* Mel. (Dall, 1921).— 1 specimen in White collection.

Mitra fultoni E. A. Smith.— 11.

Mitra catalinae (Dall).— 10.

Fusinus barbarensis (Trask).— Syn., *Fusus barbarensis* Trask (Arnold, 1903).— 1.

Fusinus arnoldi (Cossman).— Syn., *Fusus rugosus* Trask (Arnold, 1903): *Fusinus traski* Dall (Dall, 1921; Oldroyd, 1927).— 22.

Fusinus kobelti (Dall).— 6.

Fusinus monksae (Dall).— Syn., "*Fusus robustus* Trask" (Arnold,

1903).— 1.

Fusinus luteopictus (Dall).— (130). By far, the most common species of the genus.

Kelletia (Kelletia) kelletii (Forbes).—Syn., *Siphonalia kellettii* Fbs. (Arnold, 1903). Rather common. (9).

Cantharus fortis (Carpenter).— Syn., *Pisania fortis* Cpr. (Arnold, 1903).— 1 specimen; 2 additional in White collection.

Neptunea (Sulcosipho) tabulata (Baird).—Syn., *Chrysodomus tabulatus* Baird (Arnold, 1903; Dall, 1921; Oldroyd, 1927).— 3 fragments.

Exilioidea rectirostris (Carpenter).— Syn., *Chrysodomus rectirostris* Cpr. (Arnold, 1903): *Exilia rectirostris* Cpr. (Dall, 1921; Oldroyd, 1927).— 1 specimen.

Engina strongi Pilsbry and Lowe.— Syn., "*Engina carbonaria* Rve." (Dall, 1921; Oldroyd, 1927).— 2 specimens; an additional one in Miss Cook's collection.

Nassarius (Zeuxis) tegula (Reeve).— Syn., *Nassa tegula* Rve. (Arnold, 1903): *Alectrion tegula* Rve. (Dall, 1921; Oldroyd, 1927).— 55.

Nassarius (Schizopyga) californianus (Conrad).— Syn., *Nassa californiana* (Conr.) (Arnold, 1903): *Alectrion californiana* Conr. (Dall, 1921; Oldroyd, 1927).— 290.

Nassarius (Schizopyga) cerritensis (Arnold).— Syn., *Nassa cerritensis* Arn. (Arnold, 1903): *Alectrion cerritensis* Arn. (Dall, 1921; Oldroyd, 1927).— (160). Our series appears to show that this species grades into *N. californianus* at one end, and approaches very near to *N. mendicus cooperi* at the other, though none have as few axial ribs as *cooperi*.

Nassarius (Schizopyga) mendicus cooperi (Forbes).—Syn., *Nassa mendica cooperi* Fbs. (Arnold, 1903): *Alectrion cooperi* Fbs. (Dall, 1921; Oldroyd, 1927).— 135.

Nassarius (Schizopyga) perpinguis (Hinds).— Syn., *Nassa perpinguis* Hds. (Arnold, 1903): *Alectrion perpinguis* Hds. (Dall, 1921; Oldroyd, 1927).— 260.

Nassarius (Schizopyga) fossatus (Gould).— Syn., *Nassa fossata* (Gld.) (Arnold, 1903): *Alectrion fossata* Gld. (Dall, 1921; Oldroyd, 1927).— 50.

Nassarius (Schizopyga) insculptus (Carpenter).— Syn., *Nassa insculpta* Cpr. (Arnold, 1903): *Alectrion insculptus* Cpr. (Dall, 1921; Oldroyd, 1927).— 2.

Mitrella carinata (Hinds).—Syn., *Columbella carinata* Hds. (Arnold, 1903; Dall, 1921; Oldroyd, 1927): *C. carinata hindsi* (Gask.) Rve. (Dall, 1921; Oldroyd, 1927).

Mitrella carinata gausapata (Gould).— Syn., *Columbella gausapata* Gld. (Arnold, 1903; Dall, 1921; Oldroyd, 1927): *C. californiana* Gask. (Arnold, 1903): *C. carinata californiana* Gask. (Dall, 1921; Oldroyd, 1927).— (400). In this series are examples typical of each of the two above forms and

many intergrades between them. If only southern Californian specimens were considered, there would seem to be no justification in recognition of more than one race, as our shells, both fossil and Recent, show no point of division. From what is known at the present time, however, it appears that the range of the form *gausapata* extends considerably farther north than typical *carinata*. In a sense, therefore, they may be considered geographical races.

Mitrella tuberosa (Carpenter).—Syn., *Columbella tuberosa* Cpr. (Arnold, 1903; Dall, 1921; Oldroyd, 1927).— 130.

Amphissa reticulata Dall.— 3.

Amphissa versicolor Dall.— (40). Because of the great amount of variation in these species, I find it difficult to separate *reticulata* from *versicolor*, especially in the case of immature specimens. Three are referred to *reticulata* largely on account of their greater size.

Amphissa undata Carpenter.— 7.

Purpura (Pteropurpura) carpenteri (Dall).— Syn., *Murex carpenteri* Dall (Dall, 1921; Oldroyd, 1927).— 8.

Purpura (Pteropurpura) petri (Dall).— Syn., *Murex petri* Dall (Dall, 1921; Oldroyd, 1927).— 46.

Purpura (Centrifuga) leeana (Dall).— Syn., *Murex leeanus* Dall (Arnold, 1903).— (70). A rather common species, a fine growth series being preserved. An interesting feature is the similarity of the young of this species to half-grown *Tritonalia barbarensis* (Gabb) (see Plate 26, figs. 2, 3).

Purpura (Jaton) festiva (Hinds).—Syn., *Murex festivus* Hds. (Arnold, 1903; Dall, 1921; Oldroyd, 1927).— Abundant. (100).

Purpura (Jaton) gemma (Sowerby).— Syn., *Murex gemma* Sby. (Dall, 1921; Oldroyd, 1927).— 6.

Purpura (Jaton) santarosana (Dall).— Syn., *Murex santarosana* Dall (Dall, 1921; Oldroyd, 1927).— 1.

Tritonalia foveolata (Hinds).— Syn., *Ocinebra foveolata* Hds. (Arnold, 1903).— (40). Arnold's record of "*Ocinebra perita* Hds." may refer to this species.

Tritonalia interfossa (Carpenter).— Syn., *Ocinebra interfossa* Cpr. (Arnold, 1903).— 2, one typical and the other near to the form *beta* Dall.

Tritonalia poulsoni (Nuttall in Carpenter).— Syn., *Ocinebra poulsoni* Nutt. (Arnold, 1903).— (85). The most common member of the genus.

Thais biserialis (Blainville).— 38.

Thais emarginata (Deshayes).—Syn., *Purpura saxicola* Val. (Arnold, 1903).— 2 in White collection

Acanthina spirata (Blainville).— Syn., *Monoceros engonatum* Conr. (Arnold, 1903).— (85). This series varies from the high spired form, with rounded whorls, to the short, carinated one.

Trophon (Boreotrophon) orpheus (Gould).— 1.

Forreria belcheri (Hinds).— Syn., *Chorus belcheri* Hds. (Arnold,

1903).— Common.

Bursa californica (Hinds).— Syn., *Ranella californica* Hds. (Arnold, 1903).— Abundant.

Ranella (Priene) oregonensis (Redfield).— Syn., *Tritonium oregonensis* Redf. (Arnold, 1903): *Argobuccinum oregonensis* Redf. (Dall, 1921; Oldroyd, 1927).— 1 collected by Miss Edna Cook and another by J. C. Marsh.

Simnia (Neosimnia) catalinensis (Berry).— Syn., *Neosimnia catalinensis* (Berry, Nautilus, 30, 1916, p. 21).— 2 specimens in Museum collection and 2 more in White collection. Our largest measures 24x9 millimeters, and a Recent specimen in the writer's collection measures 32.5x12 millimeters. When these measurements are considered, the statement of F. A. Schilder (Proc. Mal. Soc. London, 20, 1932, p. 54) that *catalinensis* is "evidently the young of *loebbeckeana* Weinkauff" would seem palpably erroneous.

Cypraea spadicea Swainson.— 4.

Trivia californiana (Gray).— Syn., *T. californica* Gray (Arnold, 1903).— 3.

Trivia solandri (Gray in Sowerby).— 1.

Erato vitellina Hinds.— 1.

Erato columbella Menke.— 4.

Alabina tenuisculpta diegensis Bartsch.— 5.

Bittium (Lirobittium) ornatissimum Bartsch.— 1 collected by Tom Burch.

Bittium (Semibittium) rugatum Carpenter.— 2 collected by the writer and another by Miss Edna Cook. One of the features of this deposit was the scarcity of Bittiums which are usually so abundant in our Pleistocene localities.

Cerithidea californica (Haldeman).— (29). Undoubtedly washed down from salt marshes.

Seila montereyensis Bartsch.— Syn., "*Seila assimilata* C. B. Ad." (Arnold, 1903).— (100). The commonest species of the family.

Cerithiopsis antefilosa Bartsch.— 2.

Cerithiopsis cosmia Bartsch.— 29.

Cerithiopsis oxys Bartsch.— 16.

Cerithiopsis antemunda Bartsch.— 8.

Cerithiopsis halia Bartsch.— 3.

Triphora pedroana (Bartsch).— Syn., *Trifora pedroana* Bart. (Dall, 1921).— 1 in White collection.

Rissoella sp. ?— 18 specimens tentatively referred to this genus, but absence of opercula and soft parts makes the assignment uncertain. These resemble somewhat elongated specimens of *Syncera translucens* (Cpr.), but they are narrowly umbilicated and spirally striated. This may be the species described by Bartsch (Proc. U. S. Nat. Mus., 70, 1927, p. 31) as *Rissoella ? californica*, but it appears to differ from the figure of that species in much rounder body whorl and less open umbilicus.

Rissoina kelseyi (Dall and Bartsch).— Syn., *Alaba oldroydi* Dall (Nautilus, 19, 1905, p. 15).— 3.

Rissoina pleistocena Bartsch.— 1 specimen collected by Mrs. E. M. Clark.

Turritella jewettii Carpenter.— 1 very worn specimen found by J. C. Marsh.

Turritella cooperi Carpenter.— 38.

Vermicularia eburnea (Reeve).— 4.

Aletes squamigerus Carpenter.— Syn., *Serpulorbis squamigerus* Cpr. (Arnold, 1903).— 19 specimens, one of which is probably referable to *A. s. pennatus* (Mörch). Whether this latter form is of any ecological significance is questionable.

Spiroglyphus lituellus (Mörch).— 1.

Micranellum crebricinctum (Carpenter).— Syn., *Caecum crebricinctum* Cpr., "*Caecum magnum* Stearns" (Arnold, 1903): *Micranellum pedroense* Bartsch (Dall, 1921; Oldroyd, 1927; Grant and Gale, 1931).— Common. (197).

It appears to the writer that *M. pedroense* Bartsch, and "*Caecum magnum* Sts." as figured by Arnold, are the young of *M. crebricinctum* Cpr. This species, during juvenility, is slender, rather strongly curved, and the plug is longer and narrower; as it becomes older, the slender part of the shell is discarded; some of the curve being lost, and the plug becomes thicker and more blunt.

Fartulum orcutti (Dall).— 3.

Fartulum occidentale Bartsch.— Common. (920).

Littorina scutulata Gould.— 2 immature specimens.

Lacuna unifasciata Carpenter.— 65.

Iselica fenestrata (Carpenter).— Syn., *Fossarus fenestrata* Cpr. (Arnold, 1903).— 1 collected by Miss Edna T. Cook.

Hipponix antiquatus cranioides Carpenter.— 2.

Hipponix tumens Carpenter.— 2.

Crepidula onyx Sowerby.— Common.

Crepidula excavata (Broderip).— Abundant.

Crepidula lingulata Gould.— Syn., *Crepidula dorsata* Brod. (Arnold, 1903).— Common.

Crepidula nummaria Gould.— Syn., *C. navicelloides* Nutt. (Arnold, 1903): "*C. nivea* C. B. Ad." (Oldroyd, 1927).— Common.

Crepidula nummaria glottidiarum Dall.— (30). An interesting feature in the presence of this race is that no trace was found of the Brachiopod, *Glottidia*, upon which it undoubtedly lived.

Crucibulum spinosum (Sowerby).— 7.

Calyptraea contorta Carpenter.— Syn., *Galerus mammillaris* Brod. (Arnold, 1903, at least part): *Calyptraea mammillaris* Brod. (Grant and Gale, 1931, part).— (380). This is probably the only species of the genus to be found

in the Upper San Pedro formation, but it is possible that the more northern *C. fastigiata* Gld. occurred in earlier periods. *Contorta* may be a stunted, southern form of *fastigiata*, but both differ from *mammillaris*, of southern waters, in their thinner shell.

Polinices (Neverita) reclusianus (Deshayes).— Common. (45).

Polinices (Neverita) altus Dall.— Abundant. (60).

Polinices (Euspira) lewisii (Gould).— Only 1 specimen is referred to this species, although a number of individuals in our series of *Polinices* have an open umbilicus. Neither this feature nor the presence or absence of a funicle seem to be good characters in differentiating between *lewisii* and *reclusianus*. A series of specimens before me at this writing proceeds without a perceptible break from a completely closed umbilicus to a wide open one. The funicle is often present in the juvenile shell and absent in the adult. The shoulder of the whorls is not a constant feature in *lewisii*, but is usually present; it is, also, sometimes indicated in *reclusianus*. *Lewisii* grows to a much greater size than *reclusianus* and ranges considerably farther north, specimens having been taken by the writer in southeastern Alaska.

Sinum scopulosum (Conrad).— Syn., *S. debile*, of some authors; not of Gould, 1853: *S. californicum* Oldroyd (Dall, 1921; Oldroyd, 1927).— Common. (130).

Acmaea cassis Eschscholtz subsp. ?— 2 juveniles.

Acmaea cassis nacelloides Dall.— 1.

Acmaea insessa (Hinds).— (30). The fact that this species, which lives on kelp, is the only member of the genus that is at all common in the deposit, is added evidence of scarcity of rocks.

Tricolia pulloides (Carpenter).— Syn., *Phasianella pulloidea* Cpr. (Dall, 1921): *P. pulloides* Cpr. (Oldroyd, 1927).— (300). Arnold's specimens of "*Phasianella compta* Gld." should be checked with this species.

Tricolia substriata (Carpenter).— Syn., *Phasianella substriata* Cpr. (Dall, 1921; Oldroyd, 1927).— 135.

Astraea (Pomaulax) undosa (Wood).— Syn., *Pomaulax undosus* Wood (Arnold, 1903).— 12.

Leptothyra carpenteri Pilsbry.— Syn., *Homalopoma carpenteri* Pils. (Grant and Gale, 1931).— 1.

Norrisia norrisi (Sowerby).— 10.

Halistylus pupoideus (Carpenter).— Syn., *H. subpupoideus* Tryon (Dall, 1921; Oldroyd, 1927).— 8.

Tegula (Chlorostoma) gallina (Forbes).— Syn., *Chlorostoma gallina* Fbs. (Arnold, 1903).— 17.

Tegula (Chlorostoma) gallina multifilosa (Stearns).— 1.

Tegula (Chlorostoma) aureotincta (Forbes).— Syn., *Chlorostoma aureotinctum* Fbs. (Arnold, 1903).— 26.

Tegula (? Chlorostoma) ligulata (Menke).— Syn., *Chlorostoma viridulum ligulatum* Mke. (Arnold, 1903).— 19.

Tegula (Promartynia) pulligo (Martyn).— 1 specimen in White collection.

Calliostoma canaliculatum (Martyn).— Common. (70).

Calliostoma gemmulatum Carpenter.— 18.

Calliostoma tricolor (Gabb).— Abundant. (190).

Calliostoma gloriosum Dall.— 1 collected by the writer, 2 by Miss Edna T. Cook.

Calliostoma supragranosum Carpenter.— 2.

Calliostoma splendens Carpenter.— 6.

Turcica caffea Gabb.— Syn., *Thalotia caffea* Gabb (Arnold, 1903).—2.

Margarites (Lirularia) optabilis (Carpenter).— Syn., *M. o. knechti* Arn., *M. o. nodosa* Arn. (Arnold, 1903; Grant and Gale, 1931).— (30). This series includes both the typical form and the variety *acuticostatus* Carpenter.

Vitrinella williamsoni Dall.— 29.

Vitrinella eshnauri Bartsch.— 13.

Vitrinella stearnsi Bartsch.— 17.

Delphinoidea coronadoensis Arnold.— 1.

Haliotis cracherodii Leach.— 1 fragment.

Fissurella volcano Reeve.— Syn., *F. v. crucifera* Dall (Dall, 1921; Oldroyd, 1927).— 3 specimens (Museum, 2; Miss Cook, 1).

Epitonium (Opalia) wroblewskyi (Mörch).— Syn., *Opalia borealis* Gld. (Arnold, 1903).— 1.

Epitonium (Opalia) retiporosum (Carpenter).— 2.

Epitonium (Asperiscala) bellastriatum (Carpenter).— Syn., *Scala bellastriata* Cpr. (Arnold, 1903).— Common. (240).

Epitonium (Asperiscala) clarki T. S. Oldroyd.— Abundant. (490).

Epitonium (Nitidiscala) acrostephanum Dall.— 25.

Epitonium (Nitidiscala) indianorum (Carpenter).— Syn., *Scala indianorum* Cpr. (Arnold, 1903).— (32). This is a puzzling series, varying greatly in number and form of varices. It may not be true *indianorum*, though I am not able to distinguish it from young of that species. None approaches the size of adults of *indianorum* from the north.

Epitonium (Nitidiscala) tinctum (Carpenter).— (35). Lacking the color band, this species is difficult to identify in the fossil, and it is probable that mistakes have been made. 150 juveniles of this group remain undetermined.

Epitonium (Nitidiscala) cooperi Strong.— Syn., "*Scala tincta* Cpr." (Arnold, 1903): *Epitonium hindsii* Cpr. (Packard, Univ. Calif. Publ. Zool., 14, 1918, p. 319): *E. fallaciosum* Dall (Dall, 1921; Oldroyd, 1927).— 48.

Epitonium (Nitidiscala) sawinae Dall.— Syn., *E. catalinensis* Dall (Dall, 1921; Oldroyd, 1927).— 64.

Melanella micans (Carpenter).— Syn., *Eulima micans* Cpr. (Arnold, 1903).— Abundant. (1850).

Melanella oldroydi Bartsch.— Rather uncommon. (24).

Melanella rutila (Carpenter).— Abundant. (1100).

Melanella sp. ? —3 specimens, the size of *rutila*, but less slender and with higher body whorl.

Strombiformis raymondi (Rivers).— Syn., *S. riversi* Bartsch (Proc. U. S. Nat. Mus., 53, 1917, p. 339).— (17). *S. californica* Bartsch is very similar to this species and may be the same, but none of our specimens of the Recent form is as large as adults of the fossil.

Turbonilla (Turbonilla) hypolispa Dall and Bartsch.— 21.

It is with much hesitation that the writer employs here a division of subgenera different from that in general use. The easier method would be to follow, without comment, the arrangement used by Dall and Bartsch in their great "Monograph of West American Pyramidellid Mollusks," which appeared in 1909. However, after intensive study of west American Turbonillas, the writer is not convinced that the generally accepted division of the group as regards subgenera is not more arbitrary than natural. In fact, a number of excellent conchologists, known as keen students of Californian shells, have expressed their inability to separate the various subgenera of *Turbonilla* by their supposed characters. The natural inference drawn by an average student from such a condition might well be that there is no difference in value between a subgenus and a section.

It appears to the writer that Californian members of the genus *Turbonilla* fall into five natural groups, as follows: *Turbonilla* (including *Chemnitzia* and *Strioturbonilla*), *Pyrgolampros, Pyrgiscus* (including *Pyrgisculus*), *Bartschella* (*Dunkeria*), and *Mormula.*

Chemnitzia and *Strioturbonilla* have been differentiated from the subgenus *Turbonilla* because their axial sculpture does not extend onto the base and, in case of *Strioturbonilla*, because of spiral striations. In the species usually assigned to the subgenus *Turbonilla* the strength of the basal sculpture varies greatly; in some species, such as *centrota* and *gilli*, it is very weak, while in others like *acra* and *diegensis*, it is strong. At least one species, *cayucosensis* Willett (Nautilus, 43, 1929, p. 26), lacks basal sculpture in the young and shows it in the adult. As to *Strioturbonilla*: Although Dall and Bartsch state that the "spiral sculpture is always stronger than microscopic striations," in the majority of specimens examined by the writer this sculpture was not perceptible under a magnification of thirty diameters. The characters cited as a basis of separation of *Pyrgisculus* from *Pyrgiscus* appear to the writer to be only of sectional value, rather than subgeneric. Of the known Californian species, only *laminata* is here assigned to the subgenus *Bartschella. Arata*, which was included in this subgenus by Dall and Bartsch, when further material is available, may prove to be conspecific with *weldi*, generally included in *Pyrgiscus.*

Turbonilla (Turbonilla) asser Dall and Bartsch.— 500.

Turbonilla (Turbonilla) torquata (Gould).— 145.

Turbonilla (Turbonilla) stylina (Carpenter).— 111.

Turbonilla (Turbonilla) buttoni Dall and Bartsch.— 4.

Turbonilla (Turbonilla) ralphi Dall and Bartsch.— Syn., "*T. torquata*

Gld." (Arnold, 1903).— 160.

Turbonilla (Turbonilla) simpsoni Dall and Bartsch.— 22.

Turbonilla (Pyrgolampros) lowei Dall and Bartsch.— 200.

Turbonilla (Pyrgolampros) pedroana Dall and Bartsch.— 175.

The last two species have been divided solely on the difference in number of ribs on the early whorls, no other stable differences being perceptible to me. There are also some specimens that appear to bridge the gap between *pedroana* and the following species.

Turbonilla (Pyrgolampros) arnoldi Dall and Bartsch.

Turbonilla (Pyrgolampros) halia Dall and Bartsch..

Turbonilla (Pyrgolampros) keepi Dall and Bartsch.— 1500. This splendid series appears to demonstrate conclusively that the three above named were conspecific in late Pleistocene. They exhibit a surprising amount of variation and, in addition to ranging through the three already described species, there are numerous variants that, if found under some conditions, would undoubtedly be considered worthy of naming. Whether these three species are still connected, or whether the connecting links have disappeared since late Pleistocene, will remain uncertain until a larger number of Recent specimens are available for study.

Turbonilla (Pyrgiscus) sanctorum Dall and Bartsch.— 3 specimens are referred to this species, although they have a few more incised spirals than the type has. The largest of our specimens has fifteen whorls and measures: alt., 10 mm.; diam., 2.2 mm.

Turbonilla (Pyrgiscus) cf. **superba** Dall and Bartsch.— 1 specimen, taken by Mrs. E. M. Clark and donated to the Museum, appears nearest to this species, but differs from the type in position of median series of pits, which is a little anterior to the middle of the whorl instead of posterior to it; furthermore, the ribs do not terminate as abruptly at the suture as is shown in the figure of *superba*. Our series of about 1000 specimens of the subgenus *Pyrgiscus* clearly demonstrates that many of the features generally used in differentiation of the species in the group are of little value. Variation in number and strength of both spirals and axials are endless. In many groups, undoubtedly of the same species, it is difficult to find two specimens exactly alike. These facts have caused the writer to adopt an entirely different view of the definition of species in the genus *Turbonilla*, with the direct result that no new ones are named in this paper, although there are numerous specimens that are different in appearance from anything hitherto described.

Turbonilla (Pyrgiscus) vexativa Dall and Bartsch.— 2.

Turbonilla (Pyrgiscus) antestriata Dall and Bartsch.— 290.

Turbonilla (Pyrgiscus) almo Dall and Bartsch.— (460). A study of our series leads to the conclusion that the type of *almo* was not adult. For variation in the species, see Plate 26, fig. 4.

Turbonilla (Pyrgiscus) adusta Dall and Bartsch.— 1.

Turbonilla (Pyrgiscus) weldi Dall and Bartsch.— Our 80 specimens exhibit great variation and appear to show intergradation between *weldi*, *wickhami* and *arata*.

Turbonilla (Pyrgiscus) cf. **ista** Bartsch.— 2.

Turbonilla (Pyrgiscus) canfieldi Dall and Bartsch.— (193). A variable series, extending from typical *canfieldi* to *histias;* some individuals indicating close relationship to *macbridei* and *almejasensis.*

Turbonilla (Bartschella) laminata (Carpenter).— 43.

Turbonilla (Mormula) tridentata (Carpenter).— Syn., *T. ambusta* Dall and Bartsch.— 565.

Turbonilla (Mormula) regina Dall and Bartsch.— Syn., *T. catalinensis* Dall and Bartsch.— (18). Throughout the subgenus *Mormula* the number of incised lines and axial ribs, and basal sculpture vary greatly within the species, in both fossil and Recent specimens. The writer is unable to find any constant characters separating *regina* from *catalinensis,* or *ambusta* from *tridentata.*

Turbonilla (Mormula) pentalopha Dall and Bartsch.—(23). The adult of this species is quite different in appearance from the figure of the type given by Dall and Bartsch; in fact, it is much more like their figure of the type of *castanea.* The last whorl is long and rounded and, in some examples, possesses more than forty axials, and the internal lirations are so far back as to be hardly perceptible without breaking away the outer lip.

Odostomia (Chrysallida) eugena Dall and Bartsch.— 2 specimens; an additional one in Miss Cook's collection.

Odostomia (Evalea) nemo Dall and Bartsch.— (2100). By far the most abundant *Odostomia.*

Odostomia (Evalea) donilla Dall and Bartsch.— 9.

Odostomia (Evalea) cf. **phanea** Dall and Bartsch.— 1.

Odostomia (Amaura) helena Bartsch.— (188). This species varies considerably in diameter and in amount of tabulation of whorls. Some specimens show spiral sculpture.

Lepidopleurus nexus (Carpenter).— Syn., *L. heathi* Berry, *L. ambustus* Dall (Dall, 1921; Oldroyd, 1927).— 2 head and 2 median valves.

Mopalia acuta (Carpenter).— 1 head, 2 tail and 7 median valves.

Ischnochiton sanctaemonicae Berry.— 1 median valve found by Miss Cook and donated to the Museum.

Helisoma cf. **trivolvis** (Say).— 2 juveniles.

Gyraulus vermicularis (Gould).— 2.

Zonitoides arboreus Say.— 1.

1

2

3

4

Fig. 1. *Mangelia variegata* Cpr., showing intergradation between two extremes; x 2.

Figs. 2, 3. *Purpura leeana* (Dall), juv., (fig. 2), showing similarity of the young of this species to half-grown *Tritonalia barbarensis* (Gabb) (fig. 3); x 2.

Fig. 4. *Turbonilla almo* Dall and Bartsch, showing variation in the species; x 2.

JAN 27 1938

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. VIII, No. 31, pp. 407-408 JANUARY 18, 1938

A NEW HUMMINGBIRD OF THE GENUS SAUCEROTTIA FROM SONORA, MEXICO

BY

A. J. VAN ROSSEM AND THE MARQUESS HACHISUKA

Dickey Collections, California Institute of Technology

During the past spring and summer van Rossem and Hannum continued field work in southern Sonora in order to gather data supplementary to the work initiated by van Rossem in 1930 and subsequent years. Many interesting facts were discovered, some of which have been published and others are in press.

The presence of a strong Arid Tropical element in southern Sonora is now so well established that any further discoveries of tropical species or races may be considered as evidence purely additional to that already produced. One of the tropical genera of hummingbirds encountered was *Saucerottia,* whose presence was already known through the species *beryllina* (dubiously of the race *viola* Miller). An additional species of this genus was discovered during the recent field work.

Two representatives of *Saucerottia,* namely *sumichrasti* (Salvin) of Oaxaca and *ocai* (Gould) of Vera Cruz are each known from (unique?) specimens in the British Museum. They differ from other closely related members of the genus in having bronzy instead of chestnut, purplish, or blue rectrices and upper tail coverts. It is to this bronze-tailed group that the new species from Sonora belongs. The single specimen was sent, as an additional check, to J. L. Peters and Ludlow Griscom at the Museum of Comparative Zoölogy and neither has been able

to place it with any known hummingbird; neither can they associate it as a hybrid. We therefore name it as

Saucerottia florenceae sp. nov.

Type.—Female adult, no. 31,888, Dickey collections at the California Institute of Technology; Rancho Santa Barbara, 20 miles northeast of Guirocoba, southeastern Sonora, Mexico; altitude 5000 feet in the oak-pine association; June 9, 1937; collected by A. J. van Rossem and Robert Hannum.

Specific characters.—Belonging, obviously, to the *sumichrasti-ocai* group of the genus *Saucerottia* in possessing golden, bronzy-green rump, upper tail coverts, and rectrices. Above, bright, semi-iridescent, metallic grass green, darker on pileum and forehead and brighter, more coppery, on rump, upper tail coverts, and rectrices. Under parts grayish white, heavily spangled with green save on the abdominal region and under tail coverts; the spots on chin and throat smaller and more bluish green, those on the pectoral region and sides larger and more grass green. Under tail coverts chiefly grayish white, but buffy gray centrally. Auriculars dusky, surmounted by an indistinct grayish white post-ocular streak. Wings, dull black with a strong purplish hue, and white concealed bases of the flight feathers pale buff. Rectrices, (from above) golden, bronzy green, less obviously so on the outer pairs whose terminal portions are more or less dusky and whose shafts are pale chestnut; from below the coloration of the tail is similar, but the lateral rectrices are obsoletely mottled with steely blue on the subterminal portions. Bill, black, with the basal three-fourths of the mandible flesh color; iris, dark brown; feet, dull black. The measurements are: wing, 58; tail, 32; exposed culmen, 22 mm.

Range.—So far as known at present, the pine-oak association in the Sierra Madre in extreme southeastern Sonora.

Remarks.—The unique specimen was shot at late dusk as it was flying actively about the topmost branches of a leafless oak. The light, in fact, was so dim that the fallen bird was found only by the aid of a flashlight. Two other hummingbirds of unknown species were seen under similar circumstances and one is naturally tempted to speculate on the possibility of nocturnal, or at least crepuscular activity in the case of certain species.

This species is named for Florence van Rossem, the wife of the senior author.

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. VIII, No. 32, pp. 409-410 JANUARY 18, 1938

A NEW MUSKRAT FROM UTAH

BY

LAURENCE M. HUEY

Curator of Birds and Mammals, San Diego Society of Natural History

Among the mammals collected by the writer on an expedition for the San Diego Society of Natural History in southwestern Utah during the summer of 1937 is an apparently unnamed form of muskrat.

In the absence of sufficient material at hand for adequate comparison, the skulls of the muskrats secured were forwarded to Major E. A. Goldman of the Bureau of Biological Survey, Washington, D. C., where needed comparative specimens from the national collections were available. Through his kindness a number of comparisons were made and reported to the writer.

It is with pleasure that the animal is named in Major Goldman's honor as

Ondatra zibethica goldmani subsp. nov.

VIRGIN VALLEY MUSKRAT

Type.—From Saint George, Washington County, Utah; no. 12915, collection of the San Diego Society of Natural History; adult female; collected by Laurence M. Huey, August 11, 1937.

Characters.—A race of *Ondatra zibethica* larger in size than either *Ondatra zibethica pallida* or *O. z. bernardi* of the Colorado River drainage system in Arizona, and smaller than *O. z. mergens* of the Great Basin region in northwestern Nevada and northeastern California. In color, *O. z. goldmani* is somewhat similar to *O. z. bernardi* but has a heavier coating of guard hairs dorsally. Compared with *O. z. pallida, goldmani* is lighter in color; in fact *pallida*, despite its name, is the darkest of the three forms found along the lower Colorado River

drainage system. Compared with *O. z. mergens, goldmani* is somewhat paler and more uniformly light brown. Cranially, *goldmani* differs from *mergens* in having a relatively narrower, less massive skull; braincase decidedly narrower; lambdoid crest narrower, less flaring and upturned; interparietal narrower; premaxillae wider at fronto-maxillary suture; basi-occipital narrower; auditory bullae more inflated laterally. Compared with *bernardi, goldmani* has a relatively narrower, more elongated skull, with interparietal larger and longer, that is to say more extended antero-posteriorly. The bullae are distinctly larger and more fully inflated. Compared with *pallida, goldmani* has a relatively more elongated skull with a more slender rostrum. The interparietal differs as it does from that of *bernardi,* the zygomatic arches are more arched and the audital bullae more inflated.

Color and Measurements of Type.—Dorsally uniform Dresden Brown,[1] slightly darker on nose and rump, shading to lighter on sides and underparts. Tail thinly fringed on dorsal and ventral ridges, with dark, nearly black, hairs. Feet thinly covered dorsally with lighter-colored hairs. Vibrissae black. Total length, 502; tail, 215; hind foot, 76; ear, 17. *Skull:* greatest length, 59.6; zygomatic breadth, 36.9; nasals, 19.6; tooth row, 14.8.

Range.—Probably limited to the riparian association along the Virgin River in southwestern Utah, from near Zion National Park westward at least to Saint George and perhaps farther westward along the course of the Virgin River into the extreme northwestern tip of Arizona and southeastern Nevada.

Specimens examined by the writer.—*Ondatra zibethica mergens*: 1 from Eagle Lake, Lassen County, California. *Ondatra zibethica pallida:*[2] 24 from Camp Verde, Yavapai County, Arizona (type locality). *Ondatra zibethica bernardi:*[2] 9 from 4 miles south of Gadsden, Yuma County, Arizona (type locality). *Ondatra zibethica goldmani:* 7 from Saint George, Washington County, Utah (type locality).

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[1] Ridgway, Color Standards and Color Nomenclature, 1912.

[2] From collection of Bernard Bailey.

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME VIII, No. 33, pp. 411-454, plates 27-36

28898

Museum of Comparative Zoology JUN 8 1938 LIBRARY

NEW AND OBSCURE DECAPOD CRUSTACEA FROM THE WEST AMERICAN COASTS

BY

STEVE A. GLASSELL

Research Associate in Crustacea, San Diego Society of Natural History

SAN DIEGO, CALIFORNIA

PRINTED FOR THE SOCIETY

MAY 31, 1938

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BY

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INTRODUCTION

The material for this paper was collected from several sources, with localities ranging from La Jolla, California, to La Libertad, Ecuador. Twelve genera in five families are represented. Of these, three genera are proposed as new. Four genera are newly introduced to the west American fauna, three of these having been monotypic genera from west Atlantic waters, one, a monotype, from the Indo-Pacific region. Keys are given for three genera of west North American porcellanids, *Petrolisthes, Pachycheles* and the proposed genus *Pisonella,* split off from the genus *Pisosoma.* The holotypes for all the new species are deposited with the San Diego Society of Natural History.

For specimens I am indebted to Professor George E. MacGinitie of the California Institute of Technology, and Captain W. J. Seaholm and Mr. Woodbridge Williams, who brought in a splendid collection of well preserved material from southern waters, taken on a cruise of the yacht "Stranger," under the command of Captain Fred E. Lewis, of Balboa, California.

For the loan and gift of comparative material, photographs of obscure publications, literature and advice, I am under obligations to Dr. Waldo L. Schmitt, of the U. S. National Museum, Dr. Fenner A. Chace, Jr., of the Museum of Comparative Zoölogy, Mr. G. Robert Lunz, Jr., of the Charleston Museum, Dr. K. H. Barnard, of the South African Museum, and Mr. Melbourne Ward, of the Australian Museum.

To Mr. Anker Petersen, of Beverly Hills, California, who has given his own time and means to the drawing of the plates, I can but offer my thanks, with the full knowledge that his contribution is greater than my own.

CRANGONIDAE

Genus **Homoriscus** Rathbun

Homoriscus macginitiei, sp. nov.

Plate 27, figures 1-4

Type.—Female, holotype, Cat. No. 1120, San Diego Society of Natural History; from La Jolla, California, low tide; March 4, 1935; collected by George E. MacGinitie.

Diagnosis.—Rostrum anteriorly subovate, armed. Antennal scale armed with 7 or 8 teeth. Chelipeds subchelate. Telson armed with 3 pairs of lateral spines. Outer margin of dactyl of 3rd ambulatory leg armed with 11 spines.

Description.—Carapace lightly pubescent, with 7 sharp longitudinal crests; the median occupies the posterior 4/5 of carapace and is interrupted by the cervical groove; the submedian and supero-lateral crests begin near base of rostrum, the former posterior to this point. Both of these crests are less than half the length of the carapace, the supero-lateral being the shorter of the two. The infero-lateral crest begins at antennal sinus of anterior margin of carapace and is about half as long as submedian crest. Orbit semicircular, a little narrower than the black cornea beneath; outer orbital angle small and blunt-pointed. Rostrum semioval, armed anteriorly with fine, sharp teeth; upper surface lightly granulous, slightly concave. Third antennular peduncle extending its entire length past tip of rostrum. Antennular flagellum nearly 1/2 the length of the median crest of the carapace. Antennal peduncles subequal in length to that of the antennular. Antennal acicle subovate, armed on its outer margin with a row of 7 or 8 fine, sharp teeth, inner margin setose. Flagellum nearly as long as the body.

Chelipeds subchelate, somewhat resembling those of the genus *Crangon.* Manus subquadrate, upper margin carinate, straight; lower margin with a median, fixed tooth, which acts as the pollex, the distal lower edge armed with 3 sharp, triangular teeth, the proximal the largest; the dactyl is arcuate, sharp-pointed, setose on its upper crest and unarmed on its inner edge. The 1st ambulatory leg in short and stout, in comparison with the others; the lower margin of the merus and the upper margin of the carpus, propodus and dactylus are setose; the dactyl is simple and heavier than the others; of the ambulatory legs the 2nd is the longest, followed by the 3rd, 4th and 1st. The dactlyi of the 2nd, 3rd and 4th are slender, lanceolate, with their lengths as in the order given.

The outer maxillipeds have their ischium armed on the inner side with a row of spinules; the merus on the distal outer end with a spine; the propodus and dactylus subequal in length and longer than the carpus. Telson longer than broad, rounded at extremity; sides obscurely spinulous, with 3 pairs of lateral spines. Lateral lamina longer than telson; inner lamina longer than outer; outer margin of inner lamina smooth, of outer lamina spinulous.

Sexual variation and Color in life.—Unknown.

Measurements.—Female holotype: length from rostrum to tip of telson 18.3 mm., of carapace 7 mm., width of carapace 3.1 mm.

Material examined.—The two ovigerous type specimens.

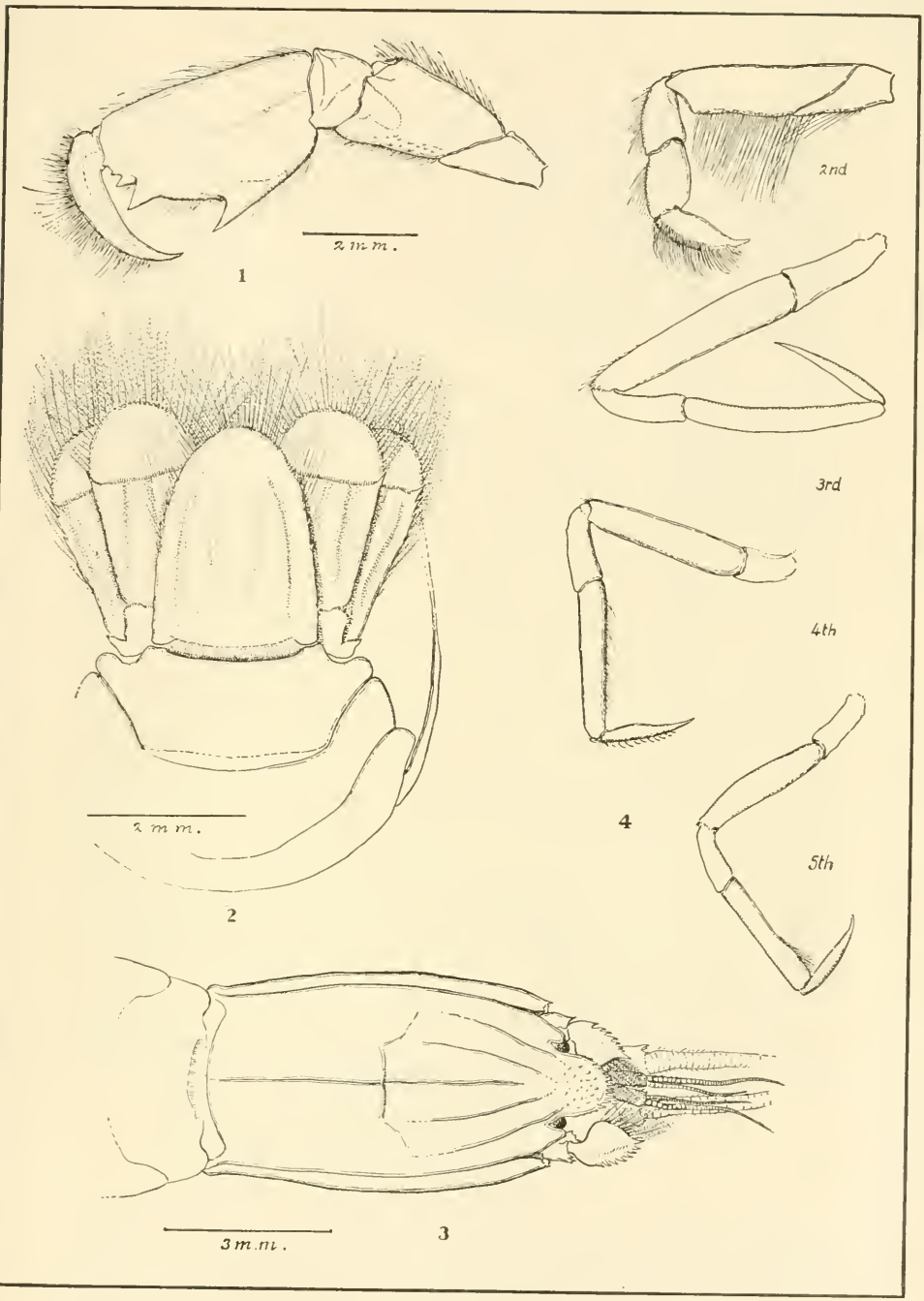


Fig. 1. *Homoriscus macginitiei* Glassell, sp. nov. Right cheliped.
Fig. 2. *Homoriscus macginitiei* Glassell, sp. nov. Telson.
Fig. 3. *Homoriscus macginitiei* Glassell, sp. nov. Carapace.
Fig. 4. *Homoriscus macginitiei* Glassell, sp. nov. Ambulatory legs.

Habitat.—Professor MacGinitie reports finding these two specimens in a small pool at extreme low water, after he had turned some stones in search of *Typhlogobius californiensis* Steindacher (the Blind Goby).

Remarks.—This proposed species is closely allied to *H. portoricensis* Rathbun, 1902. For the differences between these two species I cannot do better than quote a letter received from Dr. Fenner A. Chace, Jr., of the Museum of Comparative Zoölogy, at Harvard College, Cambridge, Massachusetts, who was kind enough to compare photographs of my drawings with a specimen of *H. portoricensis,* sent him from Havana, Cuba. Dr. Chace's findings are as follows:

"There is no doubt in my mind but that your form is specifically distinct from the Atlantic species. In comparing the two, the following differences are the most apparent: (1) Rostrum rounded rather than bluntly acute, (2) rostrum margined with a few distinct spines instead of being merely finely serrate, (3) rostrum reaching nearly to end of second antennular article rather than to middle of third segment, (4) submedian and supero-lateral crests of carapace entire instead of being minutely serrate, (5) antennal scale armed with 7 or 8 spines rather than 4 or 5, (6) the dactyl of the chelipeds is slightly shorter, the ratio of the length of the dactyl to the length of the palm being as 1 : 0.78 instead of as 1 : 0.73; consequently the apposable surface of the palm is longer, the large spine being placed more proximal, although the ratio of length to breadth of the palm is essentially the same in the two species—perhaps it is slightly broader in the Pacific species—and the armature is almost identically the same, (7) outer margin of palm of cheliped entire rather than armed with 3 or 4 small spines at distal fourth, (8) outer margin of dactyl of 3rd ambulatory leg armed with 11 spines rather than 2 or 3, (9) telson slightly longer and narrower at distal end; ratio of length to breadth as 1 : 0.60 instead of as 1 : 0.70, (10) telson armed with three pairs of lateral spines instead of a single pair at the junction of the smooth lateral margin with the setose terminal margin, and (11) outer margins of outer uropods much straighter; in *H. portoricensis* they are very convex. I might add that the inner margins of the dactyls of all the ambulatory legs in *H. portoricensis* are pectinate, irregularly so in the central portion. In the above comparisons, the characteristics of your species are given first in each case."

This proposed species is named for my good friend Professor George E. MacGinitie, of the California Institute of Technology, who collected this aberrant form and allowed me the privilege of describing it.

Genus **Betaeus** Dana

Betaeus ensenadensis, sp. nov.

Plate 28, figures 1-3

Type.—Male, holotype, Cat. No. 1121, San Diego Society of Natural History; from Estero de la Punta Banda, Ensenada, Baja California, Mexico, low tide; December 19, 1930; collected by George E. MacGinitie.

Diagnosis.—Front evenly rounded, not emarginate between the eyes. Hands similar, oblong, compressed; propodus subtruncate at apex; dactyl falcate

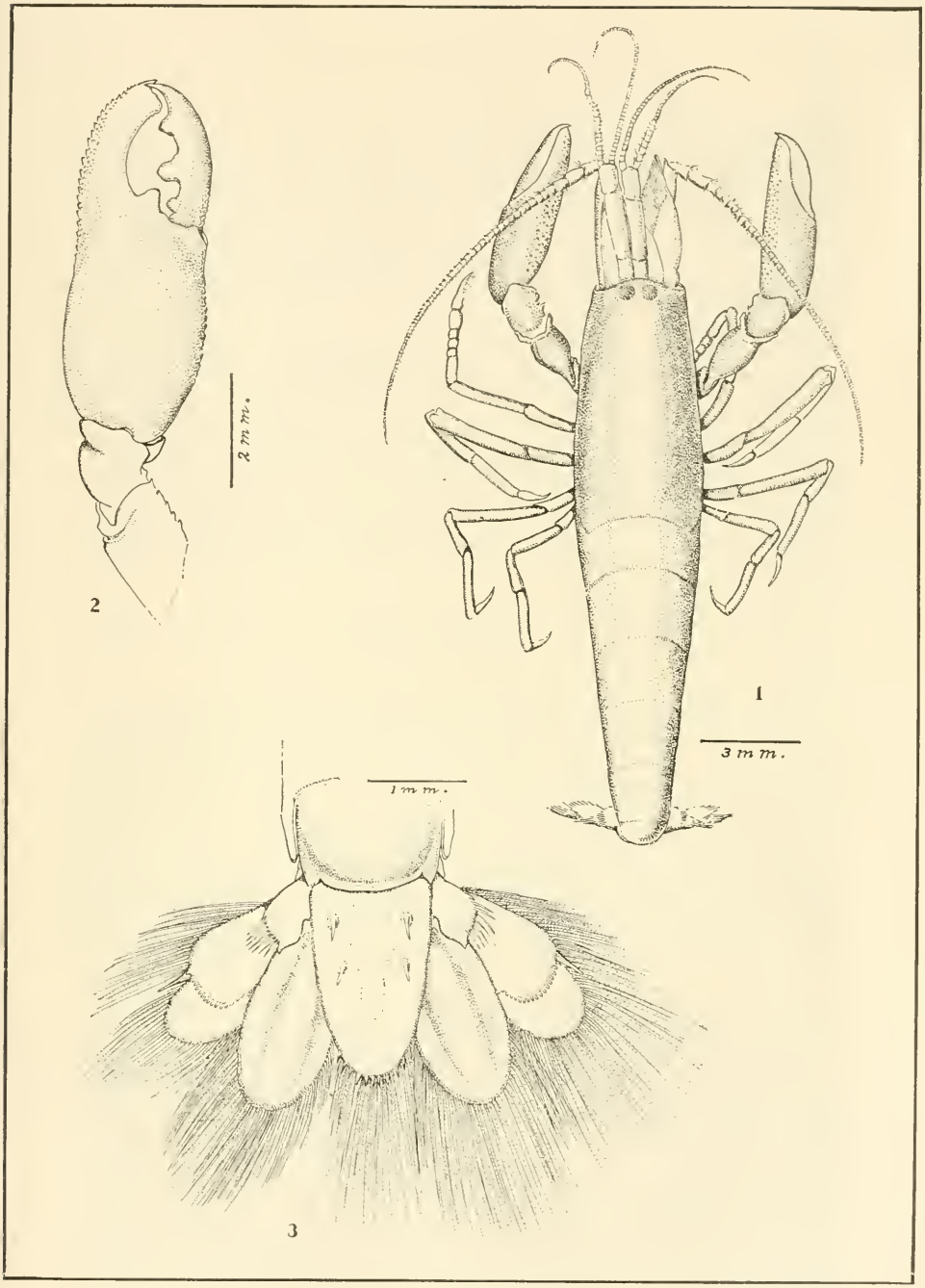


Fig. 1. *Betaeus ensenadensis* Glassell, sp. nov.
Fig. 2. *Betaeus ensenadensis* Glassell, sp. nov. Cheliped.
Fig. 3. *Betaeus ensenadensis* Glassell, sp. nov. Telson.

at tip, armed with three well-formed teeth.

Description.—Front evenly rounded, not emarginate. Carapace smooth, in life transparent, so that vital organs may be plainly seen, opaque in preservative. Second peduncle of antennule nearly twice the length of the third. Flagellum of antennae as long as chelipeds. Antennal acicle reaches past the proximal end of third peduncle of antennule, entire on outer margin, terminating in a spine; inner margin of acicle terminates near base of spine, evenly rounded at distal end, margin setose.

Chelipeds similar, 1/3 longer than length of carapace; merus lightly dentate on inner margins, outer margin with a broad oblique sinus, transverse subdistal groove deep; carpus with a vertical, lamellar projection on inner face which fits into a recess of the merus, when arm is flexed; hand oblong, compressed, lightly granulated when viewed under a lens; the length of the palm is greater than the length of the dactyl; the dactyl is strongly falcate at the apex, is armed with three strong teeth, the median the largest, the proximal the smallest; the propodus is lightly granulated, proximally armed with a single, small tooth in the gape. The propodus terminates in a single, sharp, up-turned spine, at the base of which the propodus is truncate; the fingers are crossed at their tips, and gape from base to apex.

Color in life.—The carapace, abdomen and chelipeds are covered with light tinted chromatophores in reds and blues, the fingers and telson are tinted a light purple.

Measurements.—Male holotype (not the largest specimen, but the most perfect) : length from rostrum to tip of telson 19.5 mm., of carapace 6.8 mm., of cheliped 10 mm., of manus 5.6 mm., of dactyl 3 mm. Female paratype: length from rostrum to tip of telson 21.2 mm., of carapace 6.5 mm. (the hands were missing).

Range.—So far only known from the type-locality.

Material examined.—A series of 12 specimens, from Estero de la Punta Banda, Ensenada, Baja California, Mexico; collected by George E. MacGinitie, December 19, 1930. The types were selected from this series.

A male specimen collected by the author at the same locality, December 25, 1936.

Habitat.—These specimens were found at low water in the burrows of *Callianassa* and *Upogebia.* Professor MacGinitie reports finding them in pairs.

Remarks.—This proposed species is allied to *B. longidactylus* Lockington, 1877, but differs from that species by the hands being more uniform in both the sexes, and in the individual showing little if any variation, instead of varying from long slim fingers with little gape, to those as figured by Schmitt in Univ. Calif. Publ. Zool., vol. 23, 1921, pl. 12, fig. 2, where the fingers are widely separated throughout their length. In addition, *B. ensenadensis* has the apex of its propodus subtruncate and spine-tipped, instead of being rather blunt-pointed as in *B. longidactylus;* it differs also by the dactyli being armed with 3 well-formed teeth, and being falcate distally where the fingers cross each other, instead of being unarmed, or having, at best, a small proximal tooth; the tips of the fingers crossed slightly. It also differs by the peduncles of the antennules

being of different length, the second nearly twice the length of the third, instead of being about equal length. In addition, *B. ensenadensis* is a much smaller species, a mature specimen of *B. longidactylus* measuring from rostrum to tip of telson 40.5 mm.

B. ensenadensis resembles the other known Californian representative of the genus, *B. harfordi* (Kingsley), 1878, in size, shape and relative lengths of the antennular peduncles (the 2nd being nearly twice the length of the 3rd), but differs in that the front is evenly rounded, instead of emarginate, by the hands being similar and suboblong, instead of dissimilar and oval, by the terminal spine of the antennal article extending far past the rounded inner margin, instead of extending a little past the rounded inner edge.

To Professor George E. MacGinitie of the California Institute of Technology, belongs the credit for collecting and recognizing this proposed species.

Note.—Since the above notes were written, an important extension of range for this species has been made by Professor MacGinitie, who collected two males and one ovigerous female, in *Upogebia* tubes, at False Bay, San Diego, California, on November 18, 1937. These specimens are in the author's collection.

PAGURIDAE

Paguristes sanguinimanus, sp. nov.

Type.—Male, holotype, and female, paratype, Cat. Nos. 1122 and 1123, San Diego Society of Natural History; from Punta Peñasco, Sonora, Mexico, low tide; May 2, 1935; collected by Steve A. Glassell.

Diagnosis.—Precervical portion of carapace longer than wide, areolate, laterally punctate, a gastric median groove; rostral tooth long, exceeding laterals. Chelipeds subsimilar, heavy, wide; inner margin of carpus not regularly, though distinctly, spined; hand with 4 spines on margin of palm. Flagellum reaching palm of hand, lightly ciliate. Eye-stalks long, cylindrical. Tip of antennal acicle extends but slightly past the median length of the eye-stalk, and is subequal in length to the distal end of the 3rd antennal peduncle. The flagellum of the antennule extends past the cornea.

Description.—Carapace with precervical portion longer than wide, punctate laterally and on the anterior portion of the gastric region, lightly setose laterally, smooth centrally, a median protogastric groove. The median tooth is long and slightly depressed, subtruncate at the tip, extending midway between the eye-scales, and is 1/6 the length of the eye-stalk. The laterals extend 1/3 the distance of the median, are obtuse, with a short terminal spine. The margin between the teeth is revolute and granulous.

Eye-stalks long, cylindrical, slightly outward turned, with tufts of setae on upper surface; in length they equal the length of the carpus. Ophthalmic scales triangular, sharp-pointed, margins entire.

Antennal acicle bifid at tip, a strong, proximal spine on upper surface at proximal 1/3, two outer marginal, distal spines; in length it extends a little past the median portion of the eye-stalk. The 3rd antennal peduncle has 3 spines on

the upper proximal surface, in length it slightly exceeds the tip of the acicle. The flagellum reaches the palm of the hand and is longer than the precervical portion of the carapace, is lightly ciliated.

Chelipeds subsimilar, stout, wide, heavy, the upper surface covered with short, sharp-pointed tubercles, interspersed with short setae and some pubescence, the setae not much longer than the tubercle; merus with upper distal surface triangular, inner surface smooth, its lower margin spined, outer surface roughened with granules, lower distal margin spined; carpus about as wide as long, spines more prominent on and near inner margin, outer margin not distinct, surface covered with short, sharp-pointed tubercles; manus semiovate, longer than wide, 4 conical, sharp-pointed spines on inner margin of palm, outer margin with small spines distally, entire surface set with sharp-pointed tubercles; fingers close set, tips corneous.

Ambulatory legs stout, rugose and setaceous, the first pair margined on the upper crest of the carpus, propodus and dactylus with spines, the second pair with a distal carpal spine only; the dactyli are slightly twisted.

The distal edge of the telson is armed with 4 well-spaced teeth on each segment; the right is the largest.

Color in alcohol.—The carapace, merus and carpus have a buff ground color with numerous circular red spots, the perimeter only being colored; the membranous covering of the branchials is reddish-purple. The hands are blood-red. The eye-stalks are orange-red, the base purple.

Measurements.—Male holotype (the largest specimen): length from rostrum to tip of telson 103 mm., of carapace 25 mm., of precervical portion of carapace 13 mm., width 11 mm., length of cheliped 38 mm., of merus 11 mm., of carpus 9 mm., width of carpus 8 mm., length of manus 13 mm., width of manus 10 mm., length of eye-stalk 9 mm.

Range.—Gulf of California.

Material examined.—A large series of 20 or more males, and 20 or more females, non-ovigerous, from Punta Peñasco, Sonora, Mexico, low tide; May 2, 1935; the types were selected from this series.

A series of 10 or more males, and 10 or more females, non-ovigerous, from the same location; April 12, 1937. Both series collected by the author.

Habitat.—This hermit crab, contrary to the majority of species in the genus, is apparently a littoral form, being very numerous at the type-locality, from mean low water down. The carcinoecia was a species of *Turritella.*

Remarks.—This proposed species is closely allied to *P. digueti,* Bouvier, 1892, which it resembles in many particulars, such as the shape of the front and the form of the chelipeds, particularly the hands. It differs from that species, however, by lacking distinct heavy spines on the inner carpal margin, instead of having 3 large conical spines, by the antennal acicle extending only a little past the middle of the eye-stalk, instead of 2/3 the length of the eye-stalk, by the upper proximal surface of the 3rd antennal peduncle being armed with 3 spines, instead of with 2 spines, and by the ophthalmic scales being sharp-pointed, with

margins entire, instead of having a bifid tip.

In addition to these structural differences, there is one of anatomical distortion, for *P. sanguinimanus* occupies a shell with a circular aperture, the carapace remaining normal, while *P. digueti* favors a dwelling such as *Strombus,* which distorts the carapace, depressing the precervical portion and distending the branchial regions. This may be taken as a general statement.

While both species live in the same waters, *P. digueti* has been recorded at depths ranging from 10 to 40 fathoms, and *P. sanguinimanus* has so far only been taken as a shore form.

Paguristes anahuacus, sp. nov.

Type.—Male, holotype, and female, paratype, Cat. Nos. 1124 and 1125, San Diego Society of Natural History; from Punta Peñasco, Sonora, Mexico, low tide; May 2, 1935; collected by Steve A. Glassell.

Diagnosis.—Rostral tooth long, sharp-pointed, margined, concave on upper surface, extending well between the ocular scales for more than half their length. Eye-stalks extending past merus. Flagellum not reaching distal end of carpus, lightly ciliated. Chelipeds densely tomentose; carpus with 5 inner-marginal spines; palm of hand with 3; hand nearly twice as long as wide.

Description.—Precervical portion of carapace nearly 1/3 longer than wide, tuberculate and tomentose laterally. Median tooth long, sharp, pointed, heavily margined, upper surface concave, the apex extending slightly past the center of the eye-scales; lateral teeth short, their outer margins convex, the inner concave. The margin between the laterals and the median is deep and revolute.

Eye-stalks long, nearly as long as the width of the carapace, heavy at the base, cylindrical distally, extending past the merus of the chelipeds and to the tip of the 3rd antennular peduncle. The ophthalmic scales are bifid, toothed on the outer margin, entire on the inner, and are tomentose distally.

The antennal acicle extends 2/3 the length of the eye-stalk, and is armed on its proximal inner edge with a single, sharp-pointed tooth; the outer margin has 1 or 2 teeth at the distal 1/3; the tip is bifid. The outer distal portion of the 2nd antennal peduncle extends 1/3 the length of the acicle, is bifid and spined on the outer edge. The acicle is covered with long pinnate tomentum. The distal end of the 3rd antennal peduncle just reaches past the acicle. The flagellum extends past the middle of the carpus, is subequal in length to that of the hand, and is lightly ciliated.

The chelipeds are subequal; the upper crest of the merus and the upper surfaces of both the carpus and manus are densely tomentose, though not entirely covering the fingers; merus trigonal, distally spined, a transverse subdistal groove extending down both sides, the outer surface rectangular, lightly rugose, the inner lower margin spined; carpus subequal in length to the merus, widest distally, the inner margin armed with 5 upward- and forward-pointing, corneous-tipped, conical spines, the outer margin with 8 or more smaller spines, the upper surface with numerous well-spaced tubercles; a prominent spine over

the upper hinge joint of the hand, the inner face smooth. The hands are nearly 1/2 longer than wide, the inner margin of the palm with 3 spines, upper surface flat, covered with sharp-tipped tubercles, not quite in a distinct pattern; the outer distal margin of the pollex is spined, as is the upper proximal edge of the dactyl. The tips of the fingers are corneous, spooned. The hand is densely covered with tomentum except for the inner edges of the fingers.

The ambulatory legs are thickly margined with tomentum down to the corneous tips of the dactyli; the 1st pair extend past the chelipeds by the length of their dactyli; the carpi, propodi and dactyli of the 1st pair are crested with spines, the 2nd pair with a distal carpal spine only. The distal end of the telson is wider than its base, broadly V-shaped and armed with small teeth.

Color in alcohol.—Carapace reddish-brown with light blue spots. Chelipeds orange with cream-colored spots. Ground color of ambulatory legs orange overcast with blue, which gives the appearance of a dull lavender. The eye-stalks at their distended bases are light orange; the stalk is white with a submedian band of dusky violet-blue which distinguishes the species. The antennules are light blue. The antennal flagellum has it joints light blue on their proximal end and white distally. The tomentum is cream color.

Measurements.—Male holotype: length from rostrum to tip of telson 46.6 mm., of carapace 12.6 mm., of precervical portion 8.2 mm., width 5.5 mm., length of cheliped 22 mm., of merus 6 mm., of carpus 6 mm., of manus 7.5 mm., width 4 mm., length of eye-stalk 4 mm.

Range.—So far only known from the upper end of the Gulf of California.

Material examined.—A series of at least 100 specimens of both sexes, collected at Punta Peñasco, Sonora, Mexico, low tide; May 2, 1935; and a smaller series taken at the same locality, April 12, 1937; both series collected by the author.

Habitat.—Found from extreme low water to a depth of 10 fathoms. The carcinoecia of the type specimens was a species of *Turritella.* They are abundant at the type-locality.

Remarks.—This proposed species is allied to *P. aztatlanensis* Glassell, 1937, in that the chelipeds are of similar shape, especially the hands, the flagellum being short and lightly ciliated; but it differs in that the median spine is long, extending well between the eye-scales, instead of being triangular and extending between the bases of the eye-scales, by the carpus of the chelipeds having 5 inner-marginal spines, the hand 3, instead of the carpus having 4 spines, the hand 3, and by the chelipeds being densely clothed with tomentum, instead of being lightly tufted. The front of the carapace in this proposed species somewhat resembles that of *P. spinipes* A. Milne Edwards, 1880.

This is another of the few species in this primitive genus of *Paguridae,* which may be termed littoral.

The name of this species is taken from a Nahuatl word signifying "within the water."

PORCELLANIDAE

Genus **Euceramus** Stimpson

Euceramus panatelus, sp. nov.

Plate 29

Type.—Male, holotype, Cat. No. 1126, San Diego Society of Natural History; from La Libertad, Ecuador, 6-9 fathoms; March 24, 1937; collected by Woodbridge Williams, on Captain Fred E. Lewis' yacht "Stranger."

Diagnosis.—Carapace slightly longer than twice the width, nude, transverse, minute striations; frontal region tridentate, the median slightly longer than the laterals. Antennal flagellum 1/3 longer than carapace, ciliated as in the genus *Lepidopa*. Chelipeds subequal in length to carapace, fingers gaping. Maxillipeds attached to a broadly truncate sternal segment.

Description.—Carapace slightly longer than twice the width, regularly curved like a segment of a cylinder, nude, cervical groove defined, minutely striated transversely, the lateral marginal carina only broken near posterior margin, precervical portion anteriorly granulate. Posterior margin widely V-shaped, edge revolute. Front horizontal, tridentate, teeth sharp, triangular, the median slightly the longest, separated from the laterals by a U-shaped sinus. Orbits incomplete, with concave superior margins, a microscopic spinule at its outer margin. A single lateral spine at the shoulder, behind the cervical groove. The eyes are retractile, stalks cylindrical, slightly contracted below cornea. When extended, the eyes extend past the frontal teeth and are equally as far advanced as the base of the flagellum; when retracted, they are not visible in a dorsal view. The antennules extend half their length past the eyes. The antennae are massive; the width of the first peduncle is nearly 1/4 the width of the carapace, and equal to the length of the 2nd peduncle; the 3rd is short. The flagellum is nearly 1/3 longer than the carapace, lined on its inner surface with two rows of inward directed cilia, so that when the antennae are brought together a hairy tube is formed, as in the antennae of the genus *Lepidopa*.

The chelipeds are subsimilar, unequal, slightly shorter than the length of the carapace; merus 1/2 the width of the carapace and nearly as wide as long, unarmed, rugose; the carpus is equal in length to the merus, cylindrical, widest distally, unarmed, rugose on entire outer surface; the major hand is slightly more than twice as long as wide, slightly flattened on the outer surface of the palm, distended on the inner, with a wide rugose crest on the upper margin, the outer surface is transversely rugose, the rugae anteriorly bordered with short setae. The lower margin is proximally median between the articulations, formed of an obliquely longitudinal ridge of interrupted rugae which becomes beading on the lower margin of the pollex. From the inner side of the palm, and ending at the lower marginal crest, is a row of oblique rugae. The hand is widest at the base of the pollex. The pollex is nearly horizontal, slightly upturned at the tip and armed with a short distal cutting edge. The dactyl is falcate, with the upper margin armed with a few spinules and setae, on the under side with a median blunt tooth. The fingers gape widely from base to tips. The minor hand is simi-

lar to the major, except that it is not so stout, the fingers more slender and curved at their tips; in addition they are armed on their cutting edges with a row of small teeth. These fingers also gape from base to tips. The dactyli cross their respective pollices on opposite sides.

The ambulatory legs differ from each other, not alone in length, the 2nd and 3rd being longer than the 1st, but also in the relative shape of their carpi, propodi and dactyli: all three legs are margined with fine setae. The carpi and meri of the 2nd and 3rd legs are subequal in length to their meri, while the carpus is shorter than the merus in the 1st leg. The propodi of the 1st and 2nd legs are distorted, subequal in length to the dactyl in the 1st, shorter than the dactyl in the 2nd. The dactyli of the 1st and 2nd are slightly curved at the tip, rounded on their upper surfaces and slightly flattened beneath. In the 3rd leg, which is carried up over the back, the propodus is compressed, is as wide as long, and is shorter than the dactyl; the dactyl is sub-equal in length to its carpus, is vertically compressed, curved, and with a blunt tip. The lateral edges of all three pairs of dactyli are lined with setae. The fingers of the manus in the chelate last leg are half the length of the hand. The hand is 1 mm. in length.

The sternal piece, to which the maxillipeds are attached, is broadly truncate in front. The telson is composed of 7 plates.

Sexual variation.—In the female the hands are subequal, subsimilar and slighter than those in the male. The male abdomen is narrower than that of the female.

Color in alcohol.—Carapace cream, with front red and a transverse red median band. Fingers of chelipeds flecked with red.

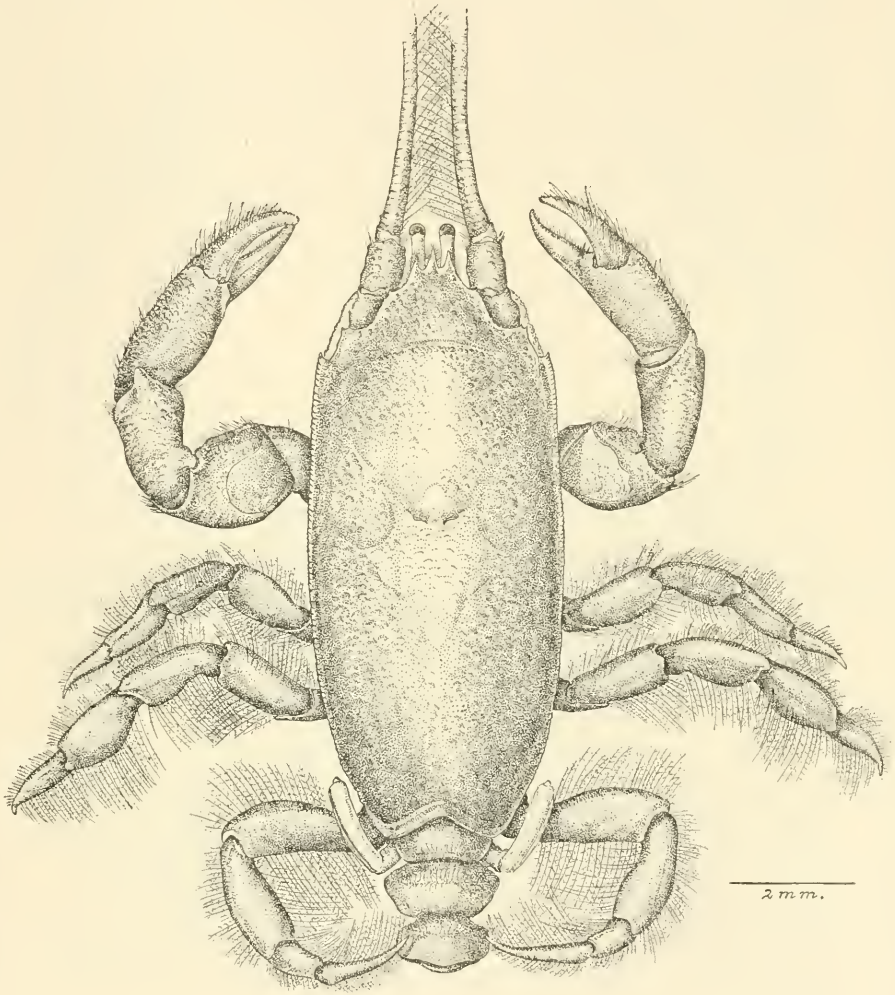
Measurements.—Male holotype: length of carapace 8.7 mm. width 4 mm., length of antennal flagellum 12.5 mm., length of major cheliped 7.5 mm., of merus 2 mm., of carpus 2 mm., of manus 3.5 mm., of dactyl 1.6 mm., width of hand 1.6 mm., length of 1st ambulatory propodus 1 mm., of dactyl 1 mm., length of 2nd ambulatory propodus 1.3 mm., of dactyl 1.5 mm., length of 3rd ambulatory propodus 0.9 mm., of dactyl 1.6 mm.

Range.—From Tenacatita Bay, Mexico, to La Libertad, Ecuador.

Material examined.—The following specimens were all collected by Woodbridge Williams, on Captain Fred E. Lewis' yacht "Stranger." 2 males and 2 females, La Libertad, Ecuador, in 6-9 fathoms, sand with mud bottom; March 24, 1937. One ovigerous female, San José, Guatemala, in 10 fathoms, sand bottom; April 1, 1937. One female, Isle Grande, Mexico, in 10-13 fathoms, sand bottom; April 8, 1937. One male and one female, Tenacatita Bay, Mexico, in 5 fathoms, fine grain sand with shell; April 11, 1937.

Habitat.—Found on a sand and mud, or sand and shell, bottom, in from 5 to 13 fathoms. Without doubt, to judge from the structure of the ambulatory legs and the disposition of the peculiarly ciliated antennae, this species is a burrowing form which remains concealed just under the surface of the sand.

Remarks.—This proposed species is closely allied to *E. praelongus* Stimpson, 1860, of the Atlantic coast, of which it is the Pacific analogue. It differs in that the dactyli of the ambulatory legs, with the exception of the first pair, which are equal to the length of their propodi, are longer than their propodi,



Euceramus panatelus Glassell, sp. nov. Male.

instead of "nearly as long as penult joint;" by the chelipeds being nearly as long as the carapace, instead of much shorter than the carapace; and by the maxillipeds being attached to a broadly truncate sternal plate, instead of a triangular sternal piece. In addition, the antennae in *E. panatelus* are much longer than those of the Atlantic species.

An examination of two specimens, a male and a female, of *E. praelongus*, furnished me by G. Robert Lunz, Jr., of the Charleston Museum, collected at Charleston, South Carolina, January 7, 1936, and a male specimen loaned me through the kindness of Dr. Waldo L. Schmitt, by the U. S. National Museum, collected by the U. S. Fish Commission Str. "Fish Hawk," off the west coast of Florida, in 3 fathoms, January 8, 1902, shows that in all three specimens the fingers of the chelipeds gape from base to apices, and are not as Stimpson described them "not gaping."

This proposed species, on account of its elongated shape and red median band, suggested a shape of cigar sold under the trade-name "Panatela."

Euceramus transversilineatus (Lockington), new combination

Plate 30

Porcellana transversilineata Lockington, Ann. Mag. Nat. Hist., ser. 5, vol. 2, 1878, p. 405 (type-locality, Boca de las Piedras, Sinaloa, Mexico; types not extant).

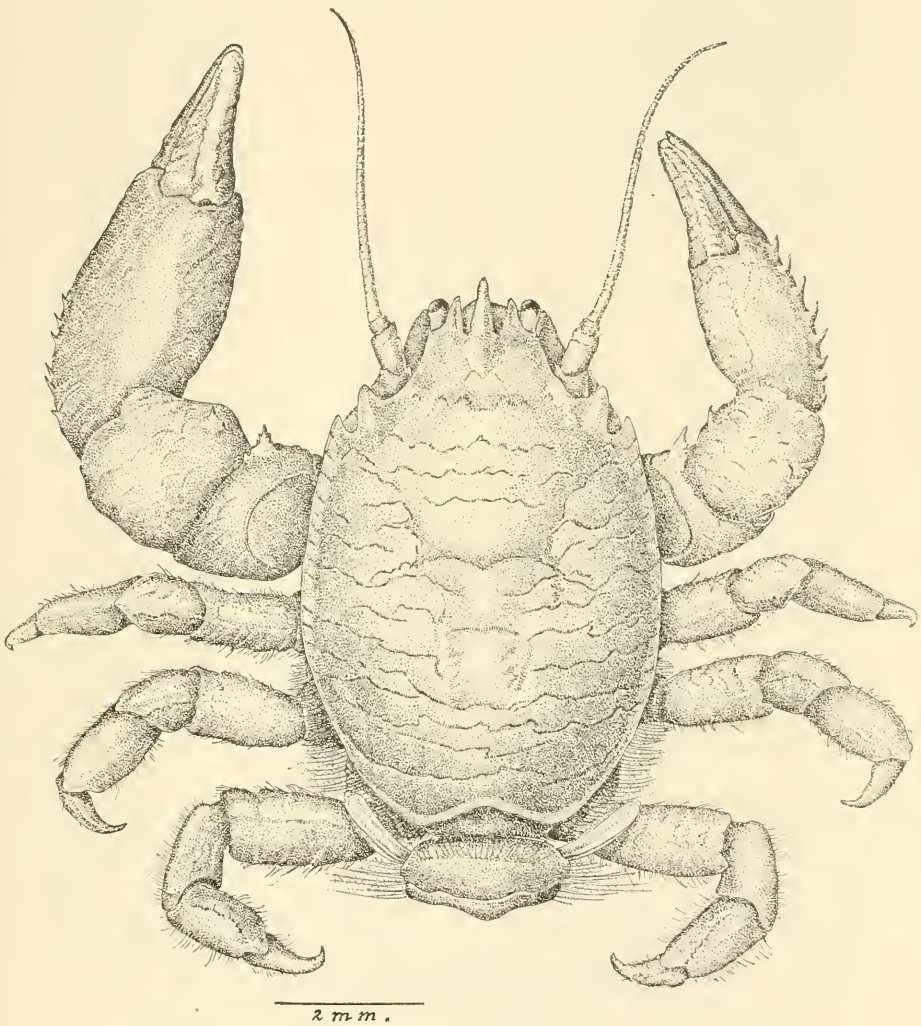
Lockington's type-locality falls well within the Gulf of California, if I am correct in assuming that Boca de las Piedras, Sinaloa (name not in the Coast Pilot), is the entrance to the Estero de las Piedras. The estero opens on the gulf 6 miles southward of the mouth of the Rio del Fuerte or Santa Maria de Ahome, and is in lat. 25° 50′ N. and long. 109° 25′ W. His second locality, Angeles Bay, Baja California, is in the upper part of the Gulf of California. This series, like all of Lockington's type material, was destroyed by fire in the San Francisco disaster of 1906.

On April 13, 1937, at Punta Peñasco, Sonora, Mexico, I took a small series of 3 specimens, at extreme low water, from the sand and shell material at the base of gorgonian corals. On May 8, 1937, at San Felipe, Baja Calfiornia, Mexico, I secured another specimen under similar collecting conditions. In addition to the above, I took, on January 1, 1932, off the north end of Tiburón Island, Gulf of California, a female in 12 fathoms. From this material I am designating one female the neotype and one male the allotype.

Neotype.—Female; Cat. No. 1127, San Diego Society of Natural History; from off the north end of Tiburón Island, Gulf of California, Mexico; January 1, 1932, 12 fathoms; collected by Steve A. Glassell.

Allotype.—Male; Cat. No. 1128, San Diego Society of Natural History; from Punta Peñasco, Sonora, Mexico; April 13, 1937, low tide; collected by Steve A. Glassell.

Diagnosis.—Carapace 1/3 longer than wide, transversely striate. Antennae subequal in length to width of carapace; basal peduncle short; flagellum naked.



Euceramus transversilineatus (Lockington). Male.

Chelipeds in females subequal, similar; in males unequal, dissimilar; merus with an inner distal spine; carpus with a submedian inner spine. Outer maxillipeds attached to strongly arched sternal segment. Dactyli of ambulatories subequal, stout, falcate. Telson of abodmen much larger in female, triangular, with 7 plates.

Description.—Carapace elongate, broadest posteriorly, about 1/3 longer than wide, regions well-marked; surface transversely crossed by well-spaced, asymmetric, distinct striations which begin at the inner edge of the obliquely plicated, thin, lateral margins. Distally the lateral margins end in a sharp, forward-pointing spine, separated from the outer antennal-marginal tooth by a V-shaped notch. Posterior margin a concave obtuse angle. Protogastric ridge distinct, toothed, divided by a median sulcus. Front tridentate, the median slightly advanced beyond the laterals, which are on a slightly lower plane. The eyes are retractile, as in the genus. The antennae are short, the 2nd peduncle the longest; flagellum naked.

The chelipeds in the female are equal, subsimilar; in the male they are dissimilar and much stouter. The merus is distally armed on the inner margin with a sharp spine, rugose on upper and lower surfaces as is the carpus and manus; carpus on upper surface rectangular, flattened, with a single, submedian, inner marginal spine, and in addition there may be one or more spinules distally. The major hand in the male is stout, thick, with rugose upper carina and a spined lower margin; the fingers gape from base to blunted tips; the dactyl is crested with smooth granules, and is armed on the under edge with 3 or more large teeth; the proximal is double; the pollex is horizontal, armed with a row of low irregular lobes. The minor hand is narrow, with a median rugate ridge which divides the outer surface of the hand into two subconcave surfaces; the lower margin is spined, the fingers long, not gaping, the tips sharp. In the female the hands are like the minor hand in the male. In both sexes the outer surface is sparsely covered with clavate setae.

The ambulatory legs are stout, rugose and lightly covered with setae; the dactyli are subsimilar, long, stout, falcate, tips corneous.

The male abdomen is much smaller than that of the female, as is the telson. The outer maxillipeds are attached to a broadly arched first sternal segment.

Color in alcohol.—Deep cream with markings of orange-red.

Measurements.—Female neotype: length of carapace 8.3 mm., width 6.1 mm., length of hand 5 mm., width 1.5 mm., length of telson 4.1 mm., width at base 2.1 mm. Male allotype: length of carapace 6.2 mm., width 4.2 mm., length of major hand 5 mm., width 2.6 mm., thickness 1.6 mm., length of telson 1.9 mm., width at base 1 mm.

Range.—So far known only from the Gulf of California, Mexico.

Material examined.—The female neotype (see neotype). A series of 2 males and 1 female from Punta Peñasco, Sonora, Mexico, taken April 13, 1937, one of which is the allotype (see allotype). A single female from San Felipe, Baja California, Mexico, taken May 8, 1937. All collected by the author.

Habitat.—Found from extreme low water, partly covered with sand and shell fragments, to a depth of 12 fathoms.

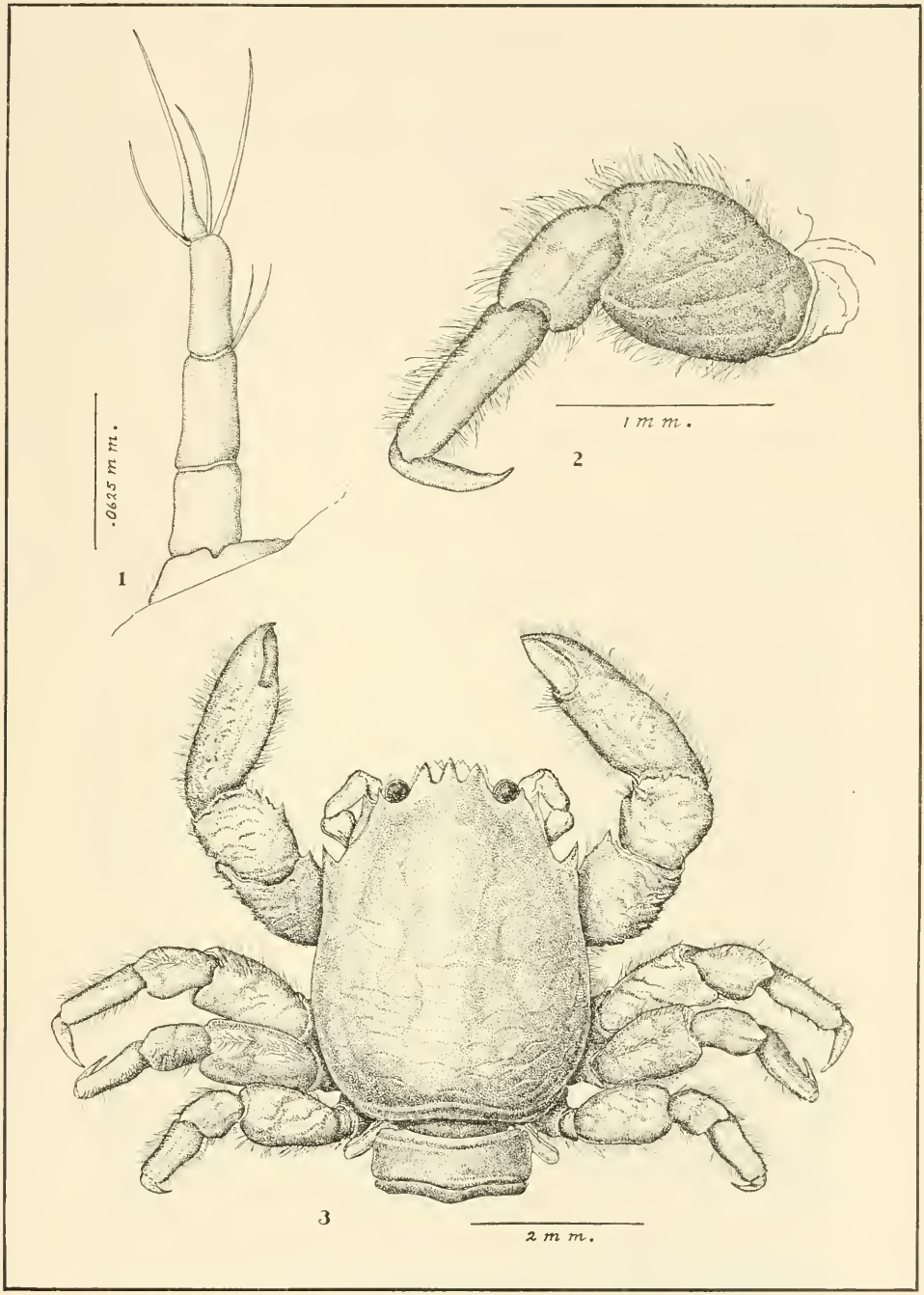


Fig. 1. *Minyocerus kirki* Glassell, sp. nov. Antennae.
Fig. 2. *Minyocerus kirki* Glassell, sp. nov. Left 3rd ambulatory leg.
Fig. 3. *Minyocerus kirki* Glassell, sp. nov. Male holotype.

Remarks.—This species of Lockington's is more closely allied to *E. praelongus* Stimpson, 1860, than it is to *E. panatelus* Glassell, although it differs in many respects from both of these species: (1) the carapace is shorter for its breadth, (2) the dactyli of the ambulatory legs are more nearly uniform and falcate, (3) the antennae are shorter and naked, (4) the major hand in the male is heavier in proportion to its length, (5) the striations on the carapace are more distinct, (6) the telson is longer in proportion to its width.

Lockington in his description of this species failed to mention the sex of his specimens, but it is evident that these were all females—"females with ova," for, had he also had adult males he would have noted the dimorphic character of the hands.

Genus **Minyocerus** Stimpson

Minyocerus kirki, sp. nov.

Plate 31, figures 1-3

Type.—Male, holotype, Cat. No. 1129, San Diego Society of Natural History; female, paratype, Cat. No. 1130, S. D. S. N. H.; from San Felipe, Baja, California, Mexico, low tide; May 11, 1937; collected by Steve A. Glassell.

Diagnosis.—Carapace convex in both directions, oblong. Chelipeds stout, rugose; carpus armed on inner margin. Ambulatory legs lightly ciliate; merus stout, rugose.

Description.—Carapace nearly 1/3 longer than wide, suboblong, convex in both directions, highest longitudinally along median line, lightly rugose, more distinct posterior to the faintly outlined cervical groove. Front with three subequal teeth, the median slightly advanced, if any, past the laterals. A sharp forward- and upward-pointing spine at the shoulder, posterior to which the sides are subparallel. Posterior margin slightly concave. The antennules extend past the apices of the frontal spines. The antennae are extremely minute and difficult to locate without staining. They are placed posterior to the outer orbital spine, have 3 movable joints and a rudimentary flagellum; their total length is not equal to the width of the cornea of the eye. The eyes are retractile, on cylindrical white stalks, and in life the cornea is extended forward as far as the tips of the lateral spines.

Chelipeds stout in the male, more slender in the female, subsimilar, slightly unequal, more pronounced in the male; merus stout, rugose on upper surface, armed on inner distal margin with a sharp spine; carpus rugose and flattened on upper surface, armed on inner margin with a large median spine, followed distally by several spinules; the length of the major hand, in the male, including the fingers, is equal to the width of the carapace, and is nearly 1/3 as wide as long; the hand in the female is shorter, but has the same length to width ratio; the outer margins are subparallel, the lower fringed with cilia; the fingers are close-fitting, their tips obtuse.

Ambulatory legs stout, margined with microscopic cilia; merus stout, nearly as wide as long, unarmed, rugose; the dactyli are lanceolate, sharp, curved at tip, nearly as long as their carpi. The telson has 7 segments.

Color in life.—Carapace with median longitudinal area white with a yellow cast, branchial areas brown with a greenish cast. Antennules blue, flagellum yellow. Palp of maxillipeds light green. Chelipeds and ambulatory legs with a whitish ground banded with brown. The carapace colors extend onto the first two abdominal segments. (Wm. A. Kirk, from field sketch).

Measurements.—Male holotype: length of carapace 3.5 mm., width 2.5 mm., length of hand including fingers 2.5 mm., width 1 mm. Female paratype: length of carapace 4 mm., width 2.8 mm., length of hand 2 mm., width 0.7 mm.

Range.—Known only from type-locality.

Material examined.—A series of 4 males and 4 gravid females, collected at San Felipe, Baja California, Mexico, May 11, 1937, by the author.

Habitat.—Found at extreme low water commensal on the sand starfish *Luidia columbia* (Gray). A pair of crabs was usually found on a single starfish, one on the dorsal, the other on the ventral side.

Remarks.—This proposed species is closely allied to *M. angustus* (Dana), 1852, but differs from that species in the following respects: the upper surface of the carpus of the chelipeds is nearly as wide as long, depressed and armed with a large inner marginal tooth, instead of being oblong, nearly entire, and by the meri of the ambulatory legs being stout, instead of slender.

Carlos Moriera, 1901, places Fritz Müller's *Porcellana stellicola,* in synonymy for *M. angustus* (Dana), and the same differences exist between my proposed species and that of Müller's, with the additional difference that in *M. kirki,* the antennae are composed of the usual three movable segments and a rudimental flagellum, instead of having six segments and a rudimentary flagellum, as figured in Ann. Mag. Nat. Hist., ser. 3, vol. 11, 1863, pl. 1, fig. 2.

This proposed species is named for my worthy friend Mr. William A. Kirk, of Los Angeles, California, who accompanied me to the Gulf of California, and made the discovery of this obscure little anomuran.

Porcellana magdalenensis Glassell

Plate 32, figures 1, 2

Porcellana magdalenensis Glassell. Trans. San Diego Soc. Nat. Hist., vol. 8, no. 21, 1936, p. 295.

At the time this species was described, the only specimens at hand were a series of five females, two of which were juvenile. Since then, a series of five males and one dismembered, ovigerous female, was collected in Acapulco Bay, State of Guerrero, Mexico, by Mr. Woodbridge Williams, on Captain Fred E. Lewis' yacht "Stranger," April 6, 1937. The adult males in this series differed in so many respects from the already described females, that they were at first considered to be a separate species. However, a close study of the juvenile and adolescent specimens proved their dimorphic character.

Description of male.—Carapace nearly smooth, except for light pubescence anteriorly, cervical groove well defined. Front broad, slightly less than half the length of the carapace, tridentate, the median twice the size of the laterals,

triangular, with a median longitudinal sulcus, microscopically margined with spinules, depressed and obtuse at the tip. The laterals are half the length of the median tooth, from which they are separated by a V-shaped sinus. Their outer spinous margins form the upper ocular margins. The lateral margin of the carapace is bordered with a row of sharp, upward- and forward-pointing spines, and is continued onto the carapace, behind the cervical groove, forming an unarmed though slightly granulose shoulder. The posterior margin is nearly straight. The antennal flagellum exceeds the length of the chelipeds.

The chelipeds are long, unequal, dissimilar; merus nearly smooth, unarmed on carpal articulation, with a wide, anteriorly produced, compressed, inner, distal lobe, well dentated on the margin in adolescents and females, nearly obsolete in adult males, carpus microscopically rugose on the slightly rounded upper surface, 1/3 longer than wide, and the upper, inner margin may or may not be armed with two small spines in the adults. The major manus is naked, stout, unarmed on margins or surfaces; the upper margin of the palm has a slight carina; a blunt longitudinal median ridge extends from the proximal end to a point near the gape; from this ridge to the outer, slightly beaded or simply rounded margin, the surface is slightly concave, as is the outer surface of the pollex. The pollex is short, blunt, stout, and armed with a single low lobe. The dactyl is smooth, slightly curved, stout and armed with a median lobe. The fingers gape from their bases to their blunt apices. There is a trace of pubescence in the gape. The minor cheliped has the two inner marginal spines of the carpus more distinct, the entire margin roughened with smaller spines; in adolescents and females the outer carpal margin has a row of upturned spines which are lacking in adult males; the manus is narrow, contorted, armed on its outer margin with a row of spines, partly concealed in pubescence, inner margin smooth; a median ridge, armed distally with sharp spines, divides the outer surface of the palm into concave surfaces, the outer pubescent. The arched, sharp-pointed dactyl is longer than the palm, crested with a row of spinules, and, on the scooped-out under surface, is setose and pubescent. The pollex is distorted, sharp-tipped, slender, and, like the dactyl, is setose and pubescent on its cutting edge.

Ambulatory legs long, as in the female; dactyl of the first pair extending past the distal end of the carpus of the chelipeds. The telson is composed of 7 plates.

Color in alcohol.—Carapace cream. Chelipeds orange-red. Ambulatory legs cream, banded with red or orange.

Measurements.—Adult male: length of carapace 3.6 mm., width 3.8 mm., length of carpus 3 mm., width 2 mm., length of major manus 5.5 mm., width 2.2 mm., length of minor manus 4.5 mm., width 1.3 mm.

Range.—From Magdalena Bay, Baja California, Mexico, to Panama.

Material examined.—In addition to the type-series from Magdalena Bay, I examined an adolescent male, from Perico Island, Panama, collected by the U. S. Fish Commission, S. S. "Albatross," October 26, 1904. This specimen was sent me for identification by Dr. Waldo L. Schmitt of the U. S. National Museum, and has been returned to that institution.

Remarks.—The juveniles of both sexes are quite similar to the adult female form.

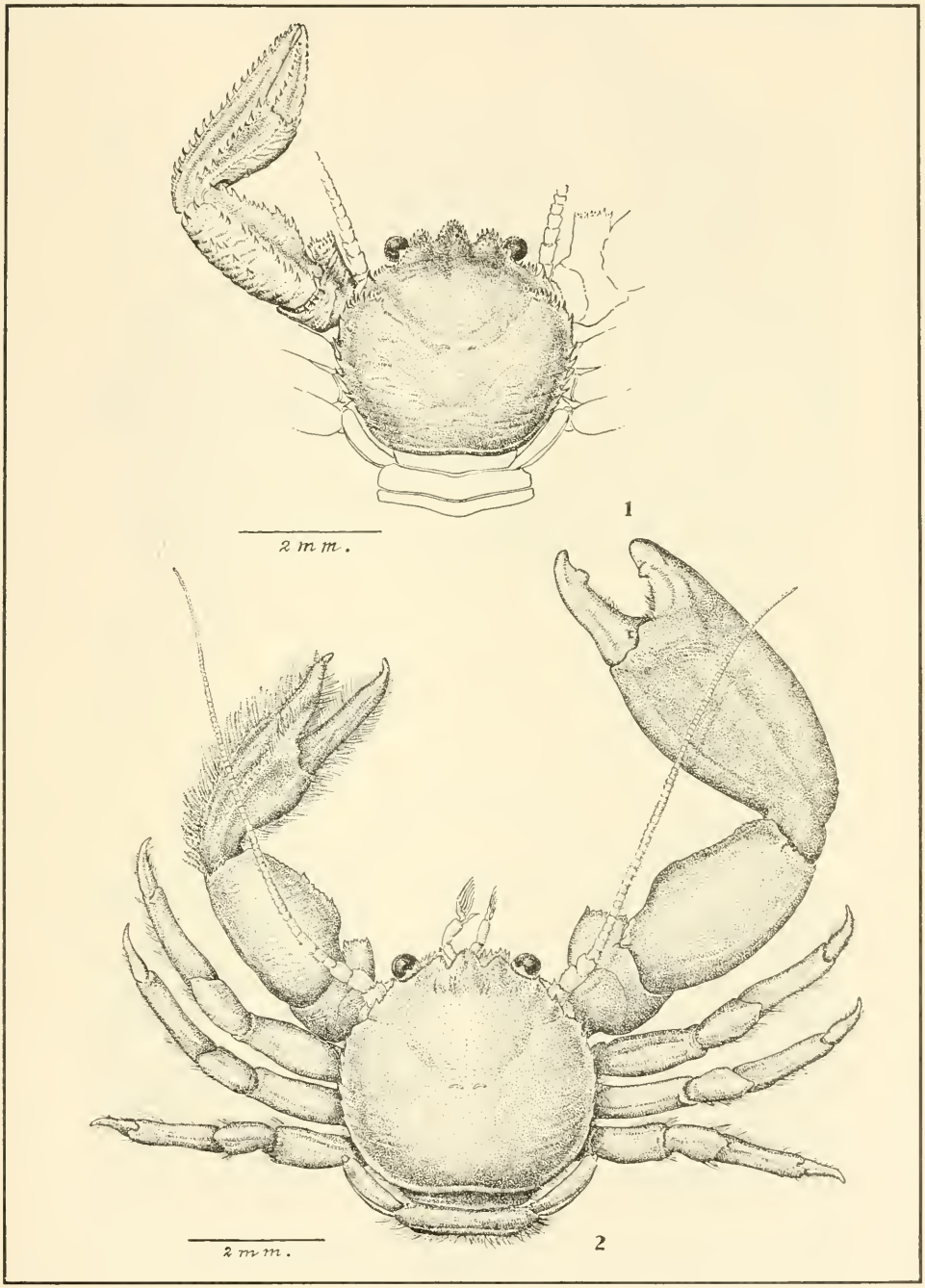


Fig. 1. *Porcellana magdalenensis* Glassell. Female.
Fig. 2. *Porcellana magdalenensis* Glassell. Male.

Ulloaia, gen. nov.

Carapace oblong-ovate, slightly longer than broad, convex, regions defined, surface squamo-tuberculate, lateral margins carinate, toothed. Front in dorsal view with a deep, wide, V-shaped, median notch, on each side of which are 2 short, multi-spined spinules, separated from each other by a notch. The median or rostral process in frontal view is subvertical, truncate and serrate on the lower edge. Eyes small, not retractile. First antennal peduncle removed from the eye, not joining the margin of the carapace; flagellum short, slightly more than 1/2 the width of the carapace. Chelipeds short; carpus cylindrical, slightly longer than wide; hands compressed, weak. Ambulatory legs short, compressed, bent; dactyli simple, not multiunguiculate.

This proposed genus is rather distantly related to *Minyocerus,* Stimpson, 1858, in which the carapace is concave, the ambulatory legs short, the dactyli not multiunguiculate. In the shape of the carapace and its peculiar front, this genus differs from all the other genera in the family; in fact, in the general appearance of the carapace, it somewhat resembles species of the genus *Mithrax,* Latreille, 1817, of the family Majidae.

Genotype.—Ulloaia perpusillia, new species, taken at Punta Peñasco (Rocky Point), Sonora, Mexico, low tide, April 12, 1937, by Steve A. Glassell.

Remarks.—This proposed genus is named for Francisco de Ulloa, conquistador, explorer and navigator, who was the first to prove that Baja California was not an island, by directing his ship into the treacherous upper reaches of the Gulf of California, after which he traversed the eastern coast of the peninsula, doubled Cabo San Lucas, at the lower end, and sailed westward into the setting sun.

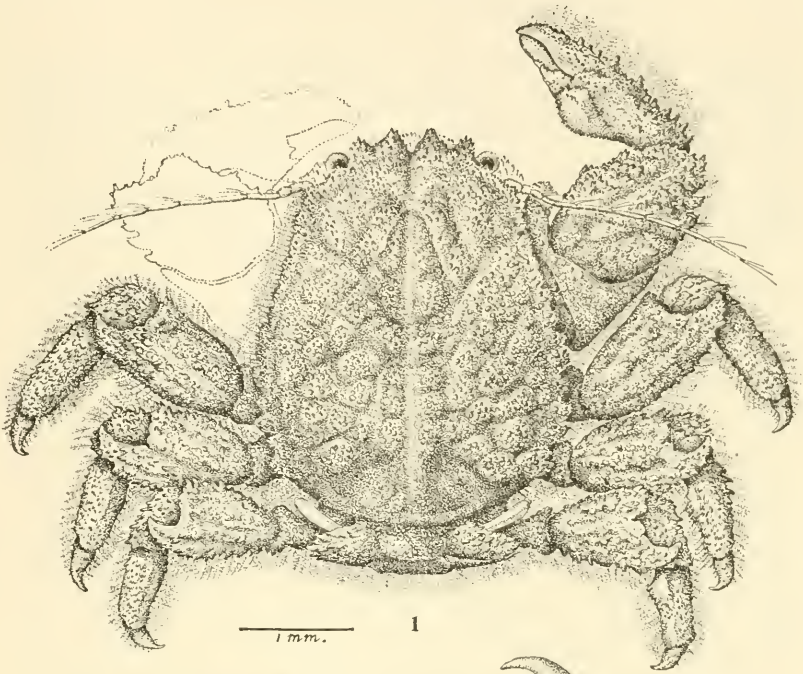
Ulloaia perpusillia, sp. nov.

Plate 33, figure 1

Type.—Male, holotype, Cat. No. 1131, San Diego Society of Natural History; from Punta Peñasco, Sonora, Mexico, low tide; April 12, 1937; collected by Steve A. Glassell.

Diagnosis.—Carapace oblong-ovate, longer than broad, convex, with a raised, longitudinal, median groove dividing the carapace into two halves. Gastric and cardiac regions raised. Posterior margin convex, entire. Branchial region with raised, flat-top tubercles. Telson with 7 plates.

Description.—Carapace oblong-ovate, longer than broad, convex, regions well defined; a longitudinal groove over the gastric and cardiac regions extending from the front to the posterior border divides the carapace into halves. The gastric and cardiac regions are raised, separated from each other by a well defined sulci; the median groove on the gastric region is bordered by longitudinal rugose ridges, on the cardiac region by rounded excrescences. The branchial regions have numerous wart-like, truncate-tipped, excrescences arising from the punctate surface, these granulose ridges and warts being more prominent on the posterior half of the carapace. The intestinal region is free from tubercles except



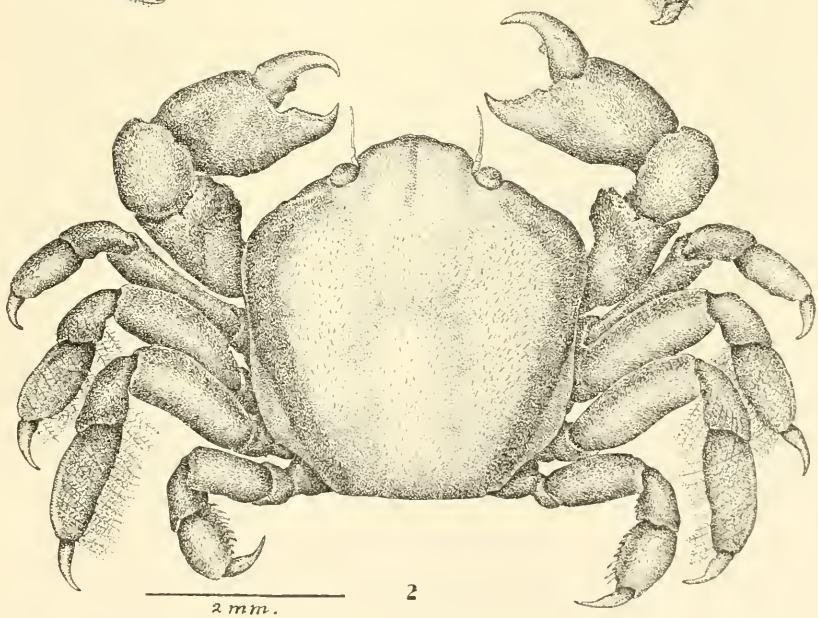


Fig. 1. *Ulloaia perpusillia* Glassell, sp. nov. Male holotype.
Fig. 2. *Fabia granti* Glassell. Male.

for small granules bordering the median groove. The front in a dorsal view has a deep, granulous, median notch, on each side of which are two forward- and upward-pointing spinules, separated from each other by a small V-shaped notch. In a frontal view the rostral process is subvertical, truncate and serrate at the tip, a sort of apron between the antennules. There is a tubercle on the upper ocular margin. The lateral margin is a carinate row of granulose lobes, diminishing in size anteriorly. The antennae are short; the joints of the flagellum rather long, with sparse cilia.

Chelipeds stout, short (only one chela remaining on the two specimens); merus short, stout, armed with an inner distal, lamellar lobe, width extremely narrow on the anterior carpal articulation, triangular and wide on the upper posterior face; carpus slightly longer than wide, inner margin with a median, serrate lobe; upper surface very rough, with an uneven median ridge bordered by sulci, a twisted row of tumid excrescences anterior to the median ridge, a row of unequal serrate lobes on the outer margin. The lower surface of the merus and carpus are on one plane, and flat. The hand is weak, compressed, shorter than the combined length of the lower surface of the carpus and merus, flexed, the arch of travel in the carpal articulation being small. The under surface of the hand is tomentose, granulate, and near the inner side are several longitudinal rows of beading. The upper surface is flattened, with a median ridge, the outer margin spinose; the inner margin of the palm has an upward-turned crest, and between this crest and the median ridge the surface is concave. Fingers short, thin, close-fitting, 1/3 the length of the hand, tips crossed.

Ambulatory legs are short, compressed, rugose, spined and lightly margined with tomentum; merus wide, postero-distal lamellar process shields 1/2 the length of the carpus on its posterior face; the carpus has a like projection over 1/3 the propodal length; propodus fluted with ridges of spinules; dactyli falcate, corneous tipped. The telson is composed of 7 plates.

Color in alcohol.—Cream tipped with orange-red.

Measurements.—Male holotype: length of carapace 3.5 mm., width 3.1 mm., length of carpus 1.5 mm., width 1.1 mm., length of hand 2.2 mm., width 1.2 mm.

Range.—Known only from the type-locality. Gulf of California.

Material examined.—One male and one ovigerous female (see type).

Habitat.—Found among gorgonian corals, sponges and bryozoan growths, at extreme low tide.

Remarks.—The aberrant type, herein described, somewhat resembles, in the shape of the carapace, *Ethusa sexdentata* (Stimpson), as figured in Smithsonian Misc. Coll., vol. 49, no. 1717, 1907, pl. 19, fig. 4, with due allowance for family differences.

Pisonella, gen. nov.

Carapace suboval, orbicular, slightly convex laterally, lateral margins high, ridged. Front depressed, arched and subentire in dorsal view, with median alone or with median lateral projections when viewed from the front. Eyes very small.

First article of outer antennae produced, joining margin of carapace, as in the genus *Porcellana*; flagellum longer than carapace. Chelipeds short, stout; carpus with inner margin armed or unarmed; hands thick. Ambulatory legs stout; dactyli simple, not multiunguiculate.

This proposed genus has a close affinity to the genus *Pisosoma* Stimpson, 1858, which is based on *P. pisum* (M. Edw.), 1837, but differs in that the eyes are smaller and that the basal segment of the antennae is removed from the ocular hiatus, instead of the eyes being large, and the first article of the outer antennae short, not reaching upper margin of the carapace and occupying a portion of the ocular hiatus, as in the genera *Pisosoma* and *Petrolisthes* Stimpson, 1858. It differs, also, from the genus *Porcellana* Lamarck, restricted Stimpson, 1858, by the carapace not being generally longer than broad, the front not tridentate and prominent.

Genotype.—*Pisonella sinuimanus* (Lockington), (=*Pisosoma sinuimanus* Lockington).

Remarks.—This genus is proposed for the reception of the following species:

Pisonella sinuimanus (Lockington), (=*Petrolisthes* (*Pisosoma*) *sinuimanus* Lockington), the genotype.

Pisonella tuberculipes (Lockington), (=*Pachycheles tuberculipes* Lockington, =*Polyonyx tuberculipes* (Lockington) Nobili).

Pisonella smithi (Glassell), (=*Pisosoma smithi* Glassell).

Pisonella erosa (Glassell), (=*Pisosoma erosa* Glassell).

KEY TO THE SPECIES OF PISONELLA

A[1]. Telson of abdomen with 7 plates. Carapace without lateral spines.

B[1]. Carapace with light transverse plications or nearly smooth. Chelipeds smooth or lightly granulated on under surface.

C[1]. Carapace nearly smooth. Chelipeds granulate; carpus armed with an inner marginal lobe; hands unequal.....*sinuimanus*

C[2]. Carapace lightly rugose. Chelipeds granulate on hands; carpus unarmed, lightly rugose; hands subsimilar.....*smithi*

B[2]. Carapace heavily eroded. Chelipeds eroded on upper surface, rugose and roughened on under surface; carpus armed, eroded; hands unequal. Ambulatory legs eroded.....*erosa*

A[2]. Telson of abdomen with 5 plates. Carapace with lateral spines. Chelipeds heavily tuberculated on upper surface, smooth on under side; carpus armed; hands in male dissimilar.....*tuberculipes*

Pisonella sinuimanus (Lockington), new combination

Plate 34, figure 2

Petrolisthes (*Pisosoma*) *sinuimanus* Lockington, Ann. Mag. Nat. Hist., ser. 5, vol. 2, 1878, p. 401 (type-locality [?], La Paz and Port Escondido, Baja

California, Mexico; types not extant).

Petrolisthes sinuimanus (Lockington) Nobili, Boll. Mus. Zool. Anat. comp. R. Univ. Torino, vol. 16, no. 415, 1901, p. 15 (Isle of Flamenco, Ecuador). —Rathbun, Proc. U. S. Nat. Mus., vol. 38, 1910, p. 599.

Pisosoma sinuimanus Lockington. Glassell, *Zoologica*: N. Y. Zoological Soc., vol. 22 (part 1), no. 4, 1937, p. 83.

This species was found at two localities on the Gulf coast of Baja California, Mexico; La Paz and Puerto Escondido, and was described by Lockington in 1878. In 1906 the type series was destroyed in the San Francisco disaster.

In 1931 and in subsequent years, I have collected this species throughout the Gulf of California, and have examined many other specimens collected in the same locality. From a small series collected at Puerto Escondido (Hidden Harbor), I am designating one male the neotype, and one female the allotype.

Neotype.—Male; Cat. No. 1132, San Diego Society of Natural History; from Puerto Escondido, Baja California, Mexico; December 19, 1931; collected by Steve A. Glassell.

Allotype.—Female; Cat. No. 1133, San Diego Society of Natural History; Puerto Escondido, Baja California, Mexico; December 19, 1931; collected by Steve A. Glassell.

Diagnosis.—Carapace suboval, anteriorly depressed, lateral margins granular. Front with a median, triangular, depressed lobe in front view. Carpus unilobate, ridged.

Description.—Carapace suboval, convex fore and aft, depressed anteriorly, lightly punctate, regions lightly defined, lateral margins granular, lightly serrate; posterior margin a concave obtuse angle; front entire in dorsal view, arched, viewed from the front, with a median, triangular, depressed lobe.

Chelipeds unequal, similar; merus with a blunt, granulate, low, longitudinal lobe upon the inner distal margin; carpus more than half as wide as long, armed with a single, granulate, blunt tooth on proximal half of anterior margin, upper surface granulate, with three longitudinal, rolling ridges, divided by furrows, median ridge the most elevated; hands unequal, subsimilar, thick, with four longitudinal rolling ridges, divided by furrows, entire outer face granulate; outer margin thick, granulate, to upturned thick tip of pollex; inner margin sharply oblique, forming a flattened, triangular surface in a vertical plane whose base is proximal, from near proximal end to a low lobe behind the upper base of the dactylus, the line from the base of the hand to the base of the finger thus forming an obtuse angle; the dactyli are sinuous, stout, cylindrical, with blunt, curved, lobular tips; dactyl of major hand armed with two blunt teeth, the pollex with one.

Ambulatory legs stout, granulate; carpus and propodus more granulate than merus; carpus of 1st and 2nd legs produced backward at posterior distal end; Dactyli stout, curved at corneous tip, setaceous, armed on under margin with a row of spines; propodus of 1st leg armed with spines on posterior margin. Epimera and abdomen fimbriate. Legs with a few setae.

Color in life.—The color varies from light cream to buff; the ventral side is slightly iridescent.

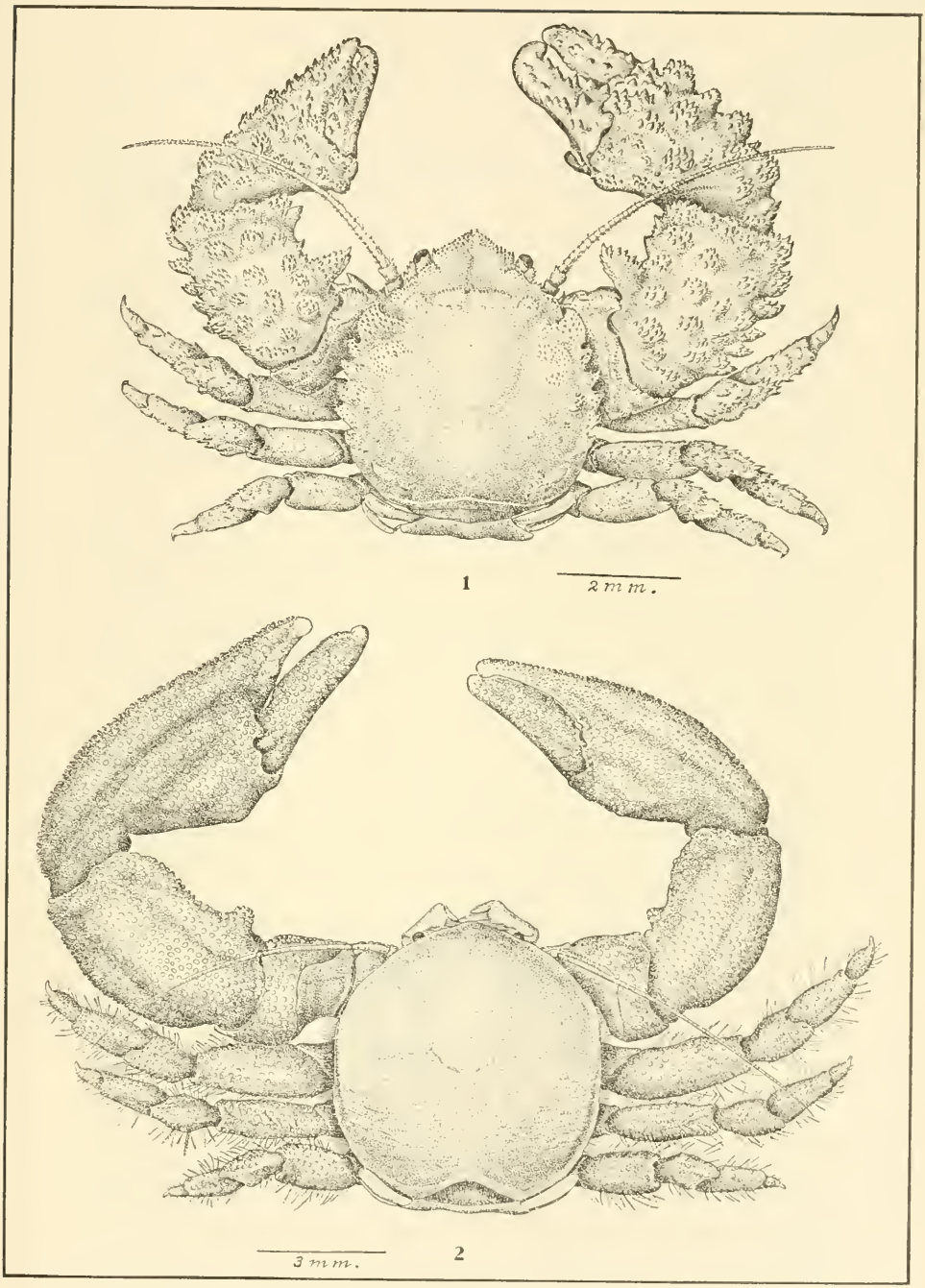


Fig. 1. *Pisonella tuberculipes* (Lockington). Male neotype.
Fig. 2. *Pisonella sinuimanus* (Lockington). Male neotype.

Measurements.—Male neotype: length of carapace 6 mm., width 6 mm. Female allotype: length of carapace 4.5 mm., width 5 mm.

Range.—From the Gulf of California to Ecuador (Nobili).

Material examined.—The types were selected from a series of 7 males and 2 females, collected by the author, at Puerto Escondido (Hidden Harbor), Baja, California, Mexico; December 19, 1931; at low tide under rocks.

A series of 20 males and 20 females, from the NE end of Tiburón Island, Gulf of California; January 2, 1932; collected by the author.

Habitat.—Found on the under side of rocks in the lower inter-tidal zone to a depth of 3 fathoms.

Remarks.—The sexes may be instantly determined by the shape of the terminal segments of the abdomen: in the male the ultimate plates are short and wide, while in the female they are subquadrate; the penultimate lateral plates in the male are long and narrow, the margins subparallel, while in the female these plates are subtriangular, widest distally. The telson is composed of seven plates.

Contrary to Lockington's description, in which he states that this is a variable species, I have found very little variation, except as to size and sex. A few specimens may show considerable roughness on the inner side of the hands, the carapace may be more punctate or lightly pubescent in others, but the carpus of the chelipeds is always armed with the proximal lobe on the anterior margin, even though distally the margin may be produced almost as far forward as the apex of the lobe. I have examined several hundred specimens of this species, all from the Gulf of California.

Pisonella tuberculipes (Lockington), new combination

Plate 34, figure 1

Pachycheles tuberculipes Lockington, Ann. Mag. Nat. Hist., ser. 5, vol. 2, 1878, p. 404 (type-locality, La Paz, Baja California, Mexico; type not extant).

Polyonyx tuberculipes (Lockington) Nobili, Boll. Mus. Zool. Anat. comp. R. Univ. Torino, vol. 16, no. 415, 1901, p. 21 (Bay of S. Elena, Ecuador). —Rathbun, Proc. U. S. Nat. Mus., vol. 38, 1910, p. 601.

Lockington described this species from 5 specimens (sex not noted, though undoubtedly females) taken at La Paz, and other ports on the Gulf of California. This type series was destroyed in the same manner and at the same time as the types of *P. sinuimanus*.

In 1935 I collected a large series of this species at Punta Peñasco, Sonora, Mexico. From this material I am designating one male, the neotype, and one female, the allotype.

Neotype.—Male; Cat. No. 1134, San Diego Society of Natural History; from Punta Peñasco, Sonora, Mexico; May 2, 1935; collected by Steve A. Glassell.

Allotype.—Female; Cat. No. 1135, San Diego Society of Natural History;

from Punta Peñasco, Sonora, Mexico; May 2, 1935; collected by Steve A. Glassell.

Diagnosis.—Carapace slightly convex; lateral margins dentate; regions defined, front projecting, subentire in dorsal view. Chelipeds in male, unequal, dissimilar, covered with granulate tubercles. Ambulatory legs tuberculate. Flagellum lightly ciliate. Telson with 5 plates.

Description.—Carapace slightly longer than wide, measured from tips of spines, convex, with scattered tufts of pubescence, regions defined, areolate. Lateral margins with 6 or 7 teeth, their upper surface covered with spinules, the anterior tooth a spine-tipped lobe, nearly twice the width of the base of the 2nd tooth; the posterior tooth is the extension of a short ridge on the carapace; inside of the lateral spines, on the carapace, are several small granulate tubercles. The protogastric ridge is sharply defined, tomentose, extending much higher than the horizontal frontal region, and separated from a small, serrate-margined, hepatic lobe, by a shallow sinus. The front projects forward, is broadly arched or subtriangular, with a median furrow; in a dorsal view the outer margin is subentire, and granulous; in a front view the median tooth is sharply depressed, triangular, acute; the lateral lobes are separated from the median by a high arched sinus, and are turned down and slightly under. The upper ocular margin has a median, granulate tubercle, as has the upper border over the basal article of the antennae. There is a sharp spine on the epistome below the basal antennal article. The flagellum of the antennae is lightly ciliate.

The chelipeds in the male are stout, unequal, dissimilar and covered on their upper surface with numerous granulous tubercles; the under surface is smooth; in the females the chelipeds are more nearly equal. Merus short on upper surface, broad, armed on inner margin with a short, lamellar, granular, distal lobe; carpus longer than broad, armed on inner margin with a proximal subhorizontal, granulous spine, nearly half as long as the inner carpal margin; from the distal base of this tooth to the distal end of the carpus, the margin is outwardly oblique and armed with several, short, stout spines. The upper surface of the carpus is covered with spinose tubercles, with upturned spines on the outer margin. The hands are thick, contorted, grotesque, unequal in the males, dissimilar, and are 1/3 longer than their carpi. The fingers of the major hand, in the male, are widely gaping, strongly curved, blunt tipped; the dactyl is falcate, armed with a large median and proximal tooth; the pollex with a smaller distal tooth. The fingers of the minor hand, which resemble those of both hands in the female, gape in a lesser degree; the dactyl is armed with a row of well formed teeth, the proximal the largest. The outer margins of the palms are bordered with spines and setae. The carpus and hands, on their upper, outer surfaces, are pubescent.

The ambulatory legs are stout, roughened with rugae and granulous tubercles, and are covered with tomentum. The telson of the abdomen is composed of 5 plates.

Sexual variation.—In the female the hands are more nearly alike than in the male. As in *P. sinuimanus*, the ultimate plates in the male telson are short and wide, the penultimate lateral plates long and narrow, the margins subpar-

allel; in the female the ultimate plates are subquadrate, the laterals widest distally.

Color in life.—Muddy grey, with a dark patch on the central regions. In alcohol the carapace and chelipeds are light pink.

Measurements.—Male neotype: length of carapace 4.1 mm., width 3.9 mm., length of carpus of major cheliped 3 mm., of hand 4 mm. Female allotype (ovigerous) : length 3.1 mm., width 3.1 mm.

Range.—From the Gulf of California, Mexico, to Ecuador (Nobili).

Material examined.—Several series of both sexes, numbering more than 25 specimens, collected by the author at San Felipe, Baja California, Mexico, June 5, 1933; and Punta Peñasco, Sonora, Mexico, May 2, 1935, and April 12, 1937.

Habitat.—This little crab is found on sponge incrusted sea-fans, but more frequently on the rough sponges themselves, at extreme low water. They are quite numerous, though obscure.

Remarks.—Lockington's description of this species is clear and unmistakable. That he placed it in the genus *Pachycheles*, was due, more to the importance placed on the conformation of the chelipeds than its anatomical structure, for while the chelipeds might very easily belong to *Pachycheles*, the epimera is entire, a peculiarity that removes it from that genus.

Nobili placed this species in the genus *Polyonyx*, with reservations, as he was satisfied that it did not meet with all the requirements of that genus. He was influenced by noting a small spinule on the dactyli of the ambulatory legs.

To obviate any chance of hidden characters remaining obscured by tomentum, I depilated the largest male in my series (the neotype), by using a weak solution of sodium hypochlorite. When thus cleaned, the dactyli show only the usual small spines on the under margin, which are to be found on nearly all the uniunguiculate dactyli in this family.

Pisonella smithi (Glassell), new combination

Pisosoma smithi Glassell, Trans. San Diego Soc. Nat. Hist., vol. 8, no. 21, 1936, p. 286 (type-locality, Miramar Beach, near Guaymas, Sonora, Mexico).

Pisonella erosa (Glassell), new combination

Pisosoma erosa Glassell, Trans. San Diego Soc. Nat. Hist., vol. 8, no. 21, 1936, p. 289 (type-locality, Magdalena Bay, Baja California, Mexico).

Types of the above two species are located in the U. S. National Museum, and with the San Diego Society of Natural History.

Key to the West North American Species of Petrolisthes

A[1]. Hands bordered with setae, margined with spines. Chelipeds with carpus armed. Ambulatory legs pubescent or setose; upper margin of meri armed.

B[1]. Front trilobate. Chelipeds pubescent; hands dissimilar; fingers with pubescence in gape.

C[1]. Carapace pubescent, with distinct striations. Carpus twice as long as wide. Meri of ambulatory legs with postero-distal end spined. Abdomen pubescent.....*hirtipes*

C[2]. Carapace naked without distinct striations. Carpus less than twice as long as wide, armed with 3 or more spines. Meri of ambulatory legs at postero-distal end unspined. Abdomen naked. .....*nigrunguiculatus*

B[2]. Front triangular. Carapace with distinct striations. Under side of hands roughened; fingers with a short pile of pubescence; carpus with 3 or more spines. Ambulatory legs setose.

C[1]. Carapace pubescent. Chelipeds pubescent; hands similar, carpus with 6 spines, twice as long as wide. Meri of ambulatory legs at postero-distal end spined. Abdomen pubescent. .....*sanfelipensis*

C[2]. Carapace naked. Chelipeds naked; hands dissimilar; carpus with 4 or 5 spines, less than twice as long as wide. Meri of ambulatory legs at postero-distal end unspined. Abdomen naked. .....*polymitus*

A[2]. Hands unmargined with setae.

B[1]. Hands unmargined with spines, similar.

C[1]. Fingers pubescent in gape. Meri of ambulatory legs at postero-distal end unspined, upper margin unarmed. Chelipeds naked; under side of hands smooth. Carapace naked.

D[1]. Carapace smooth. Carpus unarmed; margins parallel.

E[1]. Front triangular. Carpus twice as long as wide. Ambulatory legs pubescent.....*eriomerus*

E[2]. Front trilobate. Carpus more than twice as long as wide. Meri of ambulatories naked.....*gracilis*

D[2]. Carapace roughened, regions well marked. Front triangular. Carpus less than twice as long as wide, armed with a lamellar lobe.....*cinctipes*

C[2]. Meri of ambulatory legs armed on upper margin. Chelipeds with under side of hand roughened.

D[1]. Fingers pubescent in gape. Meri of ambulatory legs at postero-distal end unspined. Carapace pubescent, areolate, with distinct striations. Chelipeds pubescent, with carpi unarmed. .....*rathbunae*

D[2]. Movable finger with a short pile of pubescence only. Meri of ambulatory legs at postero-distal end spined. Carapace heavily striate. Chelipeds naked; carpi armed with 3 or more spines. .....*edwardsii*

B[2]. Hands unmargined with spines, under side smooth, dissimilar; fingers with a short pile of pubescence; carpus less than twice as long as wide. Carapace pubescent. Ambulatory legs pubescent; meri unarmed on upper margin, at postero-distal end unspined.

C[1]. Carapace with regions well marked; frontal trilobate. Chelipeds pubescent; carpus armed.....*crenulatus*

C[2]. Carapace with regions indistinct; front triangular. Chelipeds naked; carpus unarmed.....*schmitti*

B[3]. Hands margined with spines, under side roughened, similar; fingers with a short pile of pubescence. Chelipeds pubescent; carpus twice as long as wide, armed with 5 or 6 spines. Carapace pubescent, surface smooth; front triangular. Ambulatory legs setose; meri armed, postero-distal end spined.....*hirtispinosus*

A[3]. Hands unmargined with setae, margined or unmargined with spines, under side smooth. Chelipeds naked or pubescent. Meri of ambulatory legs armed.

B[1]. Carapace naked or pubescent, surface smooth. Front triangular. Chelipeds naked or pubescent; carpus twice as long as wide, armed with 3 spines; hands dissimilar, unmargined with spines; fingers with a short pile of pubescence. Meri of ambulatory legs at postero-distal end spined. Not dimorphic...*armatus*

B[2]. Carapace naked, areolate, regions well marked. Front trilobate. Chelipeds naked; carpus in female armed, 3 times as long as wide in male. Hands similar, margined with spines in female; fingers pubescent in gape. Meri of ambulatory legs at postero-distal end unspined. Dimorphic.....*tiburonensis*

Key to the West North American Species of Pachycheles

A[1]. Telson of abdomen with 5 plates.

B[1]. Front prominent, subtriangular.

C[1]. Gape of fingers naked.

D[1]. Chela with setae only. Carpus with a single serrated lobe. Carapace pubescent. .....*rudis*

D[2]. Chela with pubescence only. Carpus with 5 teeth. Carapace lightly setose.....*marcortezensis*

C[2]. Gape of fingers with setae and pubescence. Chela with pubescence only. Carpus with 2 or 3 teeth. Carapace naked except rostrum. .....*holosericus*

B[2]. Front not prominent, subarcuate. Gape of fingers naked. Chela naked. Carpus unarmed. Carapace naked.....*biocellatus*

A[2]. Telson of abdomen with 7 plates. Carpus with 3 teeth.

B[1]. Front prominent, subtriangular. Gape of fingers pubescent. Chela with pubescence and setae. Carapace naked except rostrum. .....*pubescens*

B[2]. Front not prominent, subarcuate.

C[1]. Gape of fingers with setae. Chela with setae only. Carapace lightly setose. .....*sonorensis*

C[2]. Gape of fingers naked. Chela with pubescence only. Carapace naked except rostrum.....*setimanus*

GONEPLACIDAE

Hexapus williamsi, sp. nov.

Plate 35, figures 1-4

Type.—Male, holotype; Cat. No. 1158, San Diego Society of Natural History; from San José, Guatemala, 10-13 fathoms; April 1, 1937; collected by Woodbridge Williams on Captain Fred E. Lewis' yacht "Stranger."

Diagnosis.—Carapace punctate, regions lightly defined. Front 1/4 the width of carapace, trilobed, the median not as advanced as the laterals. Chelipeds unequal; hands with a tubercle on inner, upper distal side of palm to engage with oblique stridulating ridge extending from the lateral margins of the buccal area. Sixth segment of male abdomen 1/2 longer than wide at distal end, 2-3-4-5-6 segments coalesced.

Description.—Carapace nearly 1/3 wider than long, convex fore and aft, transversely flattened, punctate, lateral margins granulated; cervical groove defines the lateral regions; gastric and cardiac regions smoother than remaining surfaces, separated by a light sulcus; a light fold over the intestinal region. The postero-lateral is short, subequal in length to the width of the ocular hiatus, with two concave margins meeting at the proximal 1/3 in forming a sharp projection. The posterior margin is slightly convex, 1/6 wider than the length of the carapace. The upper ocular margin is raised and granulose. The front is depressed, wider at the tip than between the eyes; in a front view the lateral ends project farther than the broadly triangular median lobe; the margin between the median and the laterals is granulose and concave. The eye-stalks are heavy at the base, constricted in the middle, the cornea small in proportion to the base. A narrow, oblique row of stridulations on the epistome meets the buccal cavity opposite the distal end of the merus of the 3rd maxillipeds. The abdomen of the male is slender; only the 1st and 7th segments are articulated; the five interior segments are coalesced; the penultimate segment is nearly as wide as long at distal end; the ultimate segment is as high as wide, subovate.

Chelipeds dissimilar, unequal, tomentose; the minor hand is held in a normal position, the major hand is carried perpendicular to the minor; major hand inflated, the palm nearly as wide as long, upper margin thick and, like the minor hand, with a tubercle on the inner distal face which engages with the stridulations of the epimera. The outer surface of the hands is granulose under a thick pile of tomentum. The lower margin of the major hand is sinuous, of the minor straight and beaded. The pollex in both hands is straight and the inner edge armed with 3 or 4 large blunt teeth. The dactyli are compressed, thin, fluted and armed with 3 large teeth on the major, 2 on the minor; while the dactyli slightly cross their pollices at the tip, they do not completely close from gape to apices.

The ambulatory legs are densely margined with tomentum, punctate, the 2nd the longest. Of the 1st leg the merus is trihedral, twisted, with a row of well spaced tubercles on the posterior outer margin; of the 2nd and 3rd (last) legs the merus is compressed, 3 times as long as broad, narrowing distally, and subequal in length to the carpus and propodus combined; the dactyli are as long or

longer than their propodi, in the 1st pair slightly twisted, in the 2nd and 3rd straight, long, tapering, fluted, with the crests tomentose.

Color in alcohol.—Cream underlaid with light pink on the branchial and cardiac regions. Tomentum earthy brown.

Measurements.—Male, holotype: length of carapace 5.8 mm., width 8.6 mm., of posterior margin 6.8 mm., of front 2 mm., length of major hand 4.8 mm., width 2.5 mm., length of 2nd ambulatory leg 10.8 mm., of 6th abdominal segment 2 mm., width of base 1.7 mm., width distally 1 mm., height of 7th segment 1 mm.

Range.—Known only from the type-locality (see type).

Material examined.—Only the holotype (see type).

Habitat.—Taken on a fine black sand and mud bottom in from 10 to 13 fathoms, the sand mixed with clinkers and volcanic rock.

Remarks.—This proposed species is closely allied to *H. sexpes* (Fabricius), 1798, but differs from that species: (1) by the regions of the carapace being outlined by shallow sulci, instead of being usually not perceptible, (2) by the front being partly deflexed, the lateral lobes advanced further outward and downward than the median, the width about 1/4 the width of the carapace, instead of being vertically deflexed, truncate, and about 1/5 or 1/6 the width of the carapace, (3) by the dactyl of the major hand being armed with 3 large teeth, instead of with 2 truncate teeth near the base of the inner margin, (4) by the merus of the 3rd (last) leg being 3 times as long as broad, instead of twice as long as broad, (5) by the propodus of the 3rd leg being about 1 1/2 times as long as broad, instead of semi-circular, (6) by the dactyli being as long as the propodi, sharp-pointed, fluted, straight, tapered, instead of short and thick.

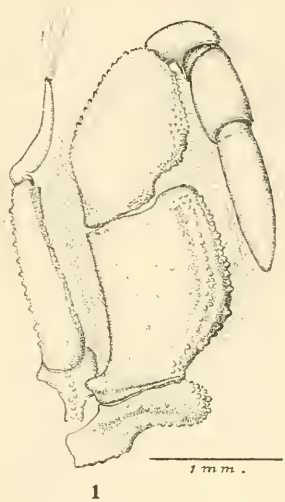
This species is named for Mr. Woodbridge Williams, student, of Pomona College, Claremont, California, who made a splendid collection of crustacea along the coasts of South and Central America, while on Captain Fred E. Lewis' yacht "Stranger," during the Spring of 1937. I am indebted to him for bringing to my attention this and many other obscure forms, which link the eastern Pacific fauna with those of the western Atlantic and Indo-Pacific regions.

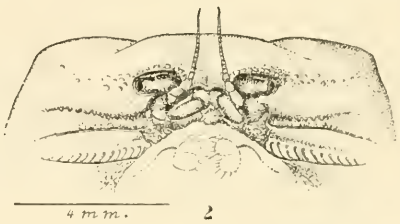
PINNOTHERIDAE

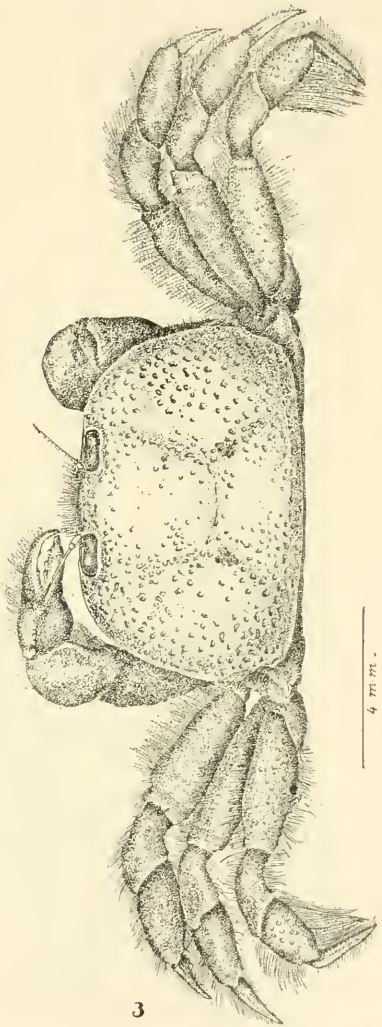
Subfamily Pinnotherlinae

Alarcónia, gen. nov.

Carapace much wider than long; integument firm, regions strongly marked; front narrow, nearly transverse, with a median groove. Orbit broadly ovate or triangular, with a wide inner hiatus, which is partly occupied by the basal antennal joint. Antennules transversely or obliquely plicated in wide fossettes which communicate with each other beneath the front. Eye-stalks very short. Epistome linear-transverse. Ischium of maxillipeds shorter or but slightly less in length than merus; merus with distal margin slightly concave; palp jointed to







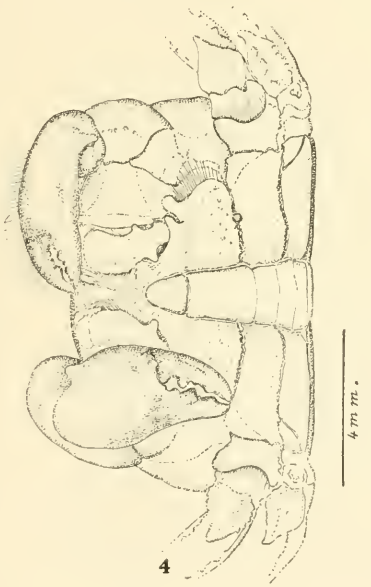


Fig. 1. *Hexapus williamsi* Glassell, sp. nov. Outer maxilliped.
Fig. 2. *Hexapus williamsi* Glassell, sp. nov. Buccal area.
Fig. 3. *Hexapus williamsi* Glassell, sp. nov. Dorsal view.
Fig. 4. *Hexapus williamsi* Glassell, sp. nov. Ventral view.

summit of merus; third joint articulated on inner side of the preceding one near base.

Chelipeds of moderate size; merus trigonous; hand large, compressed. Second ambulatory leg larger than the first; third largest of all; fourth the smallest; propodus of first leg subcircular, compressed. Abdomen in both sexes usually 7-jointed and narrower at base than width of last sternal segment. In the male, the abdominal appendages protrude from the sternal trench opposite the lateral margins of the ultimate segment, bending upward and forward in a semicircle toward the buccal opening.

This proposed genus is allied to the genus *Pinnixa* White, 1846, by the general shape of the carapace and the relative sizes and shapes of the ambulatory legs, but differs from that genus in that the ischium and merus of the outer maxillipeds are not fused or coalesced, but articulated, and by the ischium being much longer in proportion. This proposed genus is also allied to the genera *Tritodynamia* Ortman, 1894, and *Asthenognathus* Stimpson, 1858, of the subfamily Asthenognathinae. It resembles the former in that the outer maxillipeds are somewhat similar, but it differs in that the eyes are not large, the carapace not smooth, and the 2nd ambulatory leg is not the largest. It resembles the latter in that the ambulatory legs, as shown by Stimpson's figure, are quite similar, but it differs in the disposition of the segments of the palp. In addition to the above, there is also a relationship to the genus *Lambdophallus* Alcock, 1900, of the subfamily Hexapodinae, as in both genera the abdominal appendages of the male are not distally confined under the abdomen.

Genotype.—Alarcónia seaholmi, new species, taken at Acapulco, State of Guerrero, Mexico, 6 to 10 fathoms; April 6, 1937; collected by W. J. Seaholm.

Remarks.—This proposed genus is named for Hernando de Alarcón, navigator, who, under the direction of the viceroy of New Spain, was sent to support by sea the expedition of Francisco Vasquez de Coronado, to the Seven Cities of Cibola. During this adventure he discovered and explored the mouth of the Colorado River, in the year 1540.

Alarcónia seaholmi, sp. nov.

Plate 36, figures 1-5

Type.—Male, holotype, Cat. No. 1159, San Diego Society of Natural History; from Acapulco, State of Guerrero, Mexico, 6-10 fathoms; April 6, 1937; collected by Captain W. J. Seaholm, on Captain Fred E. Lewis' yacht "Stranger."

Diagnosis.—Carapace broadly ovate, regions well marked, branchial regions tuberculate and granulose, a transverse cardiac ridge, opposite the ends of which, on the branchial region, is a large tubercle. The 4th ambulatory leg extends past the merus of the 3rd by the length of the dactyl. The ischium and merus of the outer maxillipeds are long and narrow, the merus the longest.

Description.—Carapace nearly 2/3 as long as wide, convex, broadly ovate; regions well defined with sulci; branchials granulated and tuberculated, tubercles more prominent opposite the cardiac region; cardiac region with a transverse,

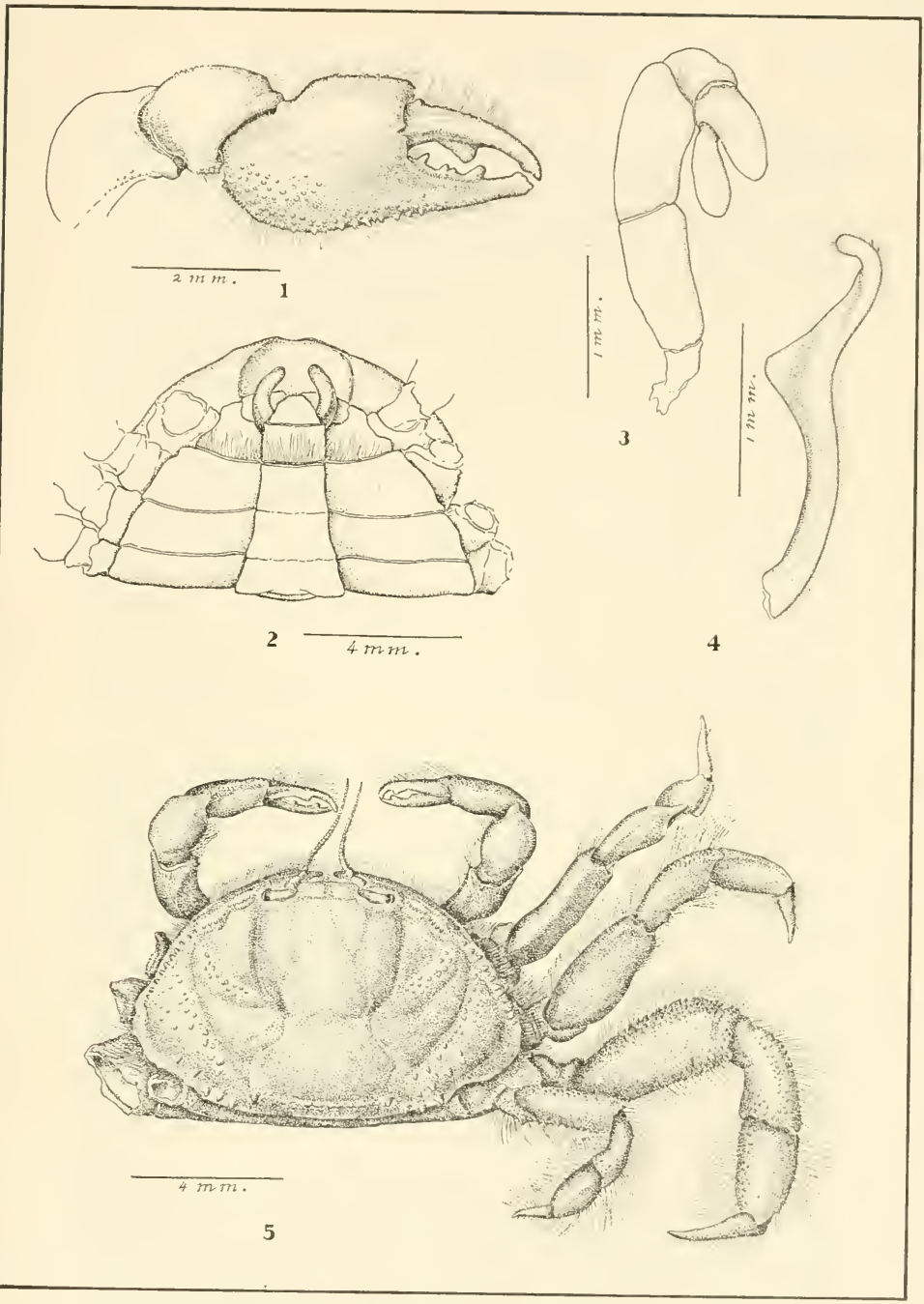


Fig. 1. *Alarcónia seaholmi* Glassell, sp. nov. Right chela.
Fig. 2. *Alarcónia seaholmi* Glassell, sp. nov. Ventral surface.
Fig. 3. *Alarcónia seaholmi* Glassell, sp. nov. Outer maxilliped.
Fig. 4. *Alarcónia seaholmi* Glassell, sp. nov. Male abdominalappendage.
Fig. 5. *Alarcónia seaholmi* Glassell, sp. nov. Dorsal view.

granulated ridge, posterior to the ridge the surface falls sharply to the posterior margin; on the branchial regions at each end of this ridge is a large tubercle. The antero-lateral margin is spinulose toward the lateral angle, granular anteriorly; the postero-lateral margin is sinuous, nearly 1/4 the width of the carapace; at the proximal end is an upright tubercle, the last of 3 tubercles which decorate the distal ends of the convex posterior margin. Front truncate, entire, slightly produced, with the outer angles rounded, and with a median groove on the upper surface; in width it is 1/7 the width of the carapace. The eye-stalks are stout at their bases, tapering sharply to the minute cornea, and with a submedian constriction; the width of the base is slightly less than the length. The length of the antennae is nearly twice the width of the front. Buccal cavity with parallel sides. Maxillipeds standing wide apart, the merus and ischium longer than broad, the merus longer than the ischium.

Chelipeds similar, equal, lightly margined with fine setae; merus trigonate, the outer lower margin armed with small tubercles; carpus subrhomboidal viewed from above, the distal, triangular end covering the upper articulation of the hand; the lower articulation of the hand is considerably posterior to that of the upper, and on the inner side of the palm; the manus from the lower proximal end to the tip of the pollex is more than twice as long as wide; the upper crested margin of the palm is a little more than half as long as the thin, granulated lower margin. The hand is compressed; pollex horizontal, thin, with a bifid tip, armed on the inner margin with 3 well-spaced teeth, the median bifid, the fingers gape from base to apices; the dactyl is armed with a large, median, subtriangular tooth.

Of the ambulatory legs the 3rd pair is the largest and longest, followed by the 2nd, 1st and 4th, all are lightly margined with setae. The 1st and 2nd pair have their carpal joints crested, more prominently on the 1st pair; the propodus of the 1st leg is compressed, subcircular, with a double, flattened, upper crest; the dactyl is horizontally compressed, lanceolate, twisted and bent upward, about as long as the propodus; the dactyl of the 2nd leg is compressed, straight, and longer than the upper margin of the propodus; the merus of the 3rd leg is 1/2 as wide as long, with a granulated upper margin and a granulated and spinous lower margin; the ischium has a strong median spine on its posterior margin; carpus nearly 1/3 longer than the propodus; dactyl is slightly shorter than the propodus, tapered, straight; of the 4th leg, whose upturned dactyl reaches past the distal end of the merus of the 3rd leg, the lower margin of the ischium is granulated, with a single subdistal tubercle; merus 3 times as long as wide, margins parallel, the lower granulated; the propodus is as wide as the merus and subequal in length to the dactyl.

The abdomen of the male is widest at the junction of the 2nd and 3rd segments, the 4th and 5th segments are coalesced, the margins of the 5th and 6th segments are parallel, there is a line of light tomentum at the articulation which extends across the sternum at this point, the base of the 7th segment is less in width than that of the truncate distal end of the 6th, its height is 1/2 its base and is semiovate. The abdominal appendages of the male protrude from a subcircular groove opposite the lateral margins of the terminal abdominal segment,

and curve upward and forward toward the buccal area. At their apices they incline toward each other.

Color in alcohol.—Light cream. Setae and tomentum red-brown.

Measurements.—Male holotype: length of carapace 5.8 mm., width 9 mm., of posterior margin 6.5 mm., width of outer orbital margins 3 mm., of front 1.3 mm., length of 1st leg 7.7 mm., of 2nd leg 9.4 mm., of 3rd leg 11.7 mm., of 4th leg 6.8 mm., of hand 4.5 mm.

Range.—Known only from type-locality (see type).

Material examined.—A single male specimen lacking the ambulatory legs on the left side.

Habitat.—Dredged on a sand and shell bottom in 6-10 fathoms. Commensal host, if any, unknown.

Remarks.—The references in the generic description to the female abdomen do not refer to this proposed species, but to a different species found on this coast, which will be described at a later date.

This proposed species is named for Captain W. J. Seaholm, who collected this and many other specimens while dredging for shells, for his sustained interest in the fields of natural science.

Pinnotheres orcutti Rathbun

Pinnotheres orcutti Rathbun, Bull. U. S. Nat. Mus., no. 97, 1918, p. 98, pl. 22, figs. 5-6, text fig. 50 (type-locality, Manzanillo, Mexico).

During the year 1936, Dr. Waldo L. Schmitt, of the U. S. National Museum, sent me for identification, among other material, a small series of *Pinnotheres* from the Tres Marias Islands, Mexico, collected by H. N. Lowe in March, 1930. These specimens I recognize as being *Pinnotheres orcutti* Rathbun, heretofore known only from the type specimen, a male. The following is a description of the female:

Diagnosis.—Carapace calcareous, suboctagonal, high, antero-lateral margins ridged. Front in dorsal view horizontal, bilobed, projecting. Dactyli of 4th pair of legs nearly 1/3 longer than the others, and longer than their propodi.

Description.—Carapace calcareous, high, convex, suboctagonal, slightly longer than broad, broadest in posterior half, uneven, branchial regions with irregular lobes; dorsal surface pubescent and bordered by a raised rim; cardiac region surrounded by a furrow except anteriorly, no median tubercle near its posterior end, as in a smaller male. Front with two advanced, blunt-pointed lobes, separated by a wide U-shaped notch, behind which runs a broad median furrow. Lateral margin long, angled, convex; postero-lateral margin short, splayed out over propodite of 3rd leg; posterior margin convex. Basal segment of antennae elongate and obliquely placed.

Merus of outer maxilliped wide and angled; the propodus differs from that of the male by being obtuse at its apex, instead of subtriangular, and by having the dactyl extending nearly to the extremity of the propodus, instead of only part way, as in the male.

Chelipeds similar, stout, manus short, increasing greatly in width toward distal end, where it is slightly less in height than superior length; lower margin

concave under gape; pollex sharply turned up at apex, armed with a blunt proximal lobe and a row of small teeth, the distal the larger, while the median tooth is the largest; dactylus wide at base, strongly arched and armed with a wide, angular tooth in front of a deep proximal notch for the reception of the proximal lobe of the pollex; the tips of the fingers are sharp-pointed and cross each other.

The ambulatory legs are narrow; the 2nd leg the longest; the dactyli of the first three pairs are subequal in length, slightly pubescent and with spine-like tips; the dactyli of the 4th pair are nearly 1/3 longer than the others, nearly straight, longer than their propodi, and with a fringe of pubescence on their lower margins.

The abdomen is circular; its terminal segment within the perimeter, its posterior margins oblique, its tip with a slight median emargination.

Color in alcohol.—Buff. Pubescence earthy brown.

Measurements.—Length of carapace: 8.5 mm., width 8.1 mm. Length of dactyli of ambulatory legs: 1st 1.6 mm., 2nd 1.7 mm., 3rd 1.4 mm., 4th 2.4 mm.

Range.—West coast of Mexico.

Material examined.—Two females, ovigerous, and one male; from Maria Madre Island, Tres Marias Islands, Mexico; March 1930; collected by H. N. Lowe. Collection of the U. S. National Museum.

One female, ovigerous, from Tenacatita Bay, Mexico; April 11, 1937; 5 fathoms; collected by Woodbridge Williams, on Captain Fred E. Lewis' yacht "Stranger."

Habitat.—Unknown. The Tenacatita Bay specimen had a calcareous worm tube attached to the carapace.

Remarks.—The use of the outer maxilliped as an infallible method of determination would have been rather difficult in the Tenacatita Bay specimen, had that one been the only specimen examined, for its outer maxillipeds were different from each other, in that the dactyli of the right and left sides were of different lengths, that of the right extending considerably past its propodus, while that of the left was short of its propodal apex. In addition, there is a marked variation in the shape of the propodus of the outer maxillipeds in the sexes, that of the males being subtriangular, with its dactyl short, while in the female the propodus is obtuse, the dactyl reaching to a point near its tip. The shape of the merus in the maxillipeds of both sexes is identical.

The only difference between the Maria Madre Island male and Rathbun's smaller type specimen is that the specimen I examined did not have the shallow right-angled indentations on either side of the 6th abdominal segment.

The eggs are abundant, globular, and slightly less than 1/3 mm. in diameter.

Fabia granti Glassell

Plate 33, figure 2

Fabia granti Glassell, Trans. San Diego Soc. Nat. Hist., vol. 7, no. 28, 1933, p. 342, pl. 26 (type-locality, Magdalena Bay, Baja California, Mexico).

While collecting at San Felipe, a small fishing village near the head of the Gulf of California, in Baja California, Mexico, I took a large series of this

species which were found in a tide pool, commensal with *Crucibulum spinosum* (Sowerby). A series of more than 75 females and 15 males was collected at this locality on May 9, 1937. A description of the heretofore unknown male follows:

Description.—Carapace calcareous oviform or urnal, surface flat, depressed, with widely separated short hairs; anterior margins raised with pubescence; regions not defined; antero-lateral margins strongly converging posteriorly; posterior margin straight, deflexed, entire, as wide as the outer ocular width. Front broadly arched, entire, with upper median surface depressed and pubescent. The cervical groove is shallow, leading back from the upper margins of orbits. Eyes small, pigmented. Antennae minute, though long and slender.

Chelipeds similar, stout, short; merus crested with short pubescence; carpus depressed on upper surface, lightly pubescent on margins; hands short and wide, proximally inflated on inner side of palm; palm as wide as long, with an upper, broadly arched, pubescent carina; lower margin horizontal, an indistinct or obsolete, longitudinal, median ridge on outer surface. Pollex short, horizontal, except for sharply upturned, spine-like tip, armed on inner edge with an oblique, granulose cutting edge. Dactyl strongly curved at tip, and armed on the inner edge with a single submedian tooth. The fingers are close fitting, their tips crossing.

Ambulatory legs compressed, with spatulate propodi; the dactyli compressed, slightly curved, with needle-like, corneous tips. The 2nd and 3rd legs with plumose natatory hairs on the carpus and propodus. The meri are margined with a close pile of pubescence.

The sides of the abdomen converge from the 1st and 2nd to the 7th segment, the latter being semioval; the 1st and 2nd segments are nearly as wide as the sternum at this point.

Color in alcohol.—Buff. Pubescence dirty yellow.

Measurements.—Of largest male: length of carapace 3.7 mm., width 3.5 mm., width of posterior margin 1.6 mm., of front between the inner ocular margins 1.2 mm., length of hand 1.8 mm., height of palm 1.3 mm. Of smallest breeding specimen: length of carapace 2.3 mm., width 2.1 mm.

Range.—Throughout the Gulf of California, Mexico.

Habitat.—Found commensal in *Crucibulum, Acmaea* and *Crepidula.* The type specimen having been taken in a worm tube does not truly indicate its host, but rather that the holotype was disturbed in the dredge material.

Remarks.—This miniature male is undoubtedly a free swimmer, as the natatory hairs on the ambulatory legs would indicate. That it spends its time, other than in the breeding season, in a free state may be questioned, as a number of the males taken in this series were alone with their host. They may be nocturnal.

The genus *Fabia,* which is apparently restricted to American waters, has six recognized species at the present time, and of these species little is known of the males, a circumstance due to their size. Wells, 1928, described the male of *Fabia subquadrata* Dana, 1851, which, to judge from the text and figures, remarkably resembles *Pinnotheres concharum* (Rathbun), 1893, a species that I have frequently found in *Volsella capax* (Conrad), along with the female of *Fabia lowei* Rathbun.

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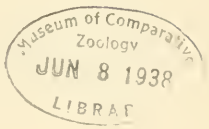

A STUDY OF THE SKULL OF THE PLEISTOCENE STORK, CICONIA MALTHA, MILLER

BY

LOYE MILLER

University of California at Los Angeles

SAN DIEGO, CALIFORNIA

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A STUDY OF THE SKULL OF THE PLEISTOCENE STORK, CICONIA MALTHA, MILLER

28898

BY

LOYE MILLER

University of California at Los Angeles

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Dr. Chester Stock of California Institute of Technology has been good enough to place in my hands, for study, a fairly complete skull of the Asphalt Stork (*Ciconia maltha*) from the McKittrick Pleistocene asphalt. The rostral portion of the specimen has suffered several fractures which render the profile of the beak uncertain, but the cranial portion warrants discussion.

Previous knowledge of the species was summed up in a special paper by the present writer in 1932 (Condor, vol. 34, Sept., 1932, pp. 212-216). At that time the skull was known only from a very unimportant fragment of the upper mandible and from a fairly well preserved lower mandible.

Study of these and the more abundant trunk and limb remains led to the following statement: "This material differs from all living American storks and is included in the species *Ciconia maltha* originally described from Rancho La Brea. . . . Generic distinction between *Euxenura* and *Ciconia* is based largely on external features and even these features are considered by some students to exhibit insufficient differences to warrant recognition of the separate genus *Euxenura*.

"Conceding that the differences between existing forms are of generic value, the form under discussion would not agree with either genus and a new genus would be necessary. While there is little question that, were the asphalt stork restored to us in its entirety, it would likely exhibit characters sufficient for its generic distinction, yet for the sake of simplicity it is referred, in the absence of those superficial characters, to the genus *Ciconia*."

The last sentence of this quotation indicates a degree of conservativeness to which I freely confess and which has been adhered to fairly consistently for the several years during which the fossil birds have been a major interest. *Ciconia* is the typical genus of Ciconiformes and since the skeletal parts heretofore examined differed from *Ciconia* in no radical

fashion, the fossil bird was assigned to that genus.

Examination of the cranial parts of the stork skulls available brings to light a number of differences which can be applied in the study of fossil birds, i. e. characters not lost with the entombment of the specimen.

Whether or not these osteologic characters are more significant than those of the exo-skeleton is not pertinent—the fact remains that they are more available to the paleontologist.

Six rather widely separated genera of storks were examined in this study, *Xenorhynchus* from Africa, *Leptoptilus* from India, *Ciconia* from Europe, *Euxenura* from South America, and *Ajaia* and *Mycteria* from Central America being available. The cranial differences appear mainly in the occipital and basisphenoidal regions, although the general proportions of the actual brain capsule appear to be significant. *Xenorhynchus, Leptoptilus,* and *Ajaia* are so far divergent from the fossil form that they may be set aside in the present study. The closest affinities appear to lie with *Mycteria, Ciconia,* and *Euxenura.*

Mycteria has a broad, flat skull when viewed in either profile. With the sphenoidal rostrum horizontal, the interorbital region is nearly the highest point of the profile. The naso-frontal area is almost as high as that of the cerebrum. There is no appreciable lift of the skull over the cerebral hemispheres. Quite in contrast are the other two genera. The highest point in the profile is posterior to the orbits where the skull rises in two swellings to accommodate the hemispheres, with a distinct sagittal depression between. The naso-frontal area is very low. In all these respects, the fossil cranium agrees with *Ciconia* and *Euxenura.*

When viewed from the rear with the sphenoidal rostrum horizontal, there appear three major differences: (1) the ratio of transverse to vertical axis; (2) the size of the occipital area of muscle attachment in relation to cranium; and (3) the pattern that the intermuscular lines trace upon the occipital plane.

The following table of cranial diameters illustrates point number one with a fair degree of satisfaction.

Table of Measurements of the Brain Case

	Maximum Depth	Maximum Width	Ratio
Ciconia maltha	39.7 mm.	55.5 mm.	72%
Ciconia alba	34.1 mm.	47.2 mm.	72%
Euxenura maguari	34.5 mm.	51.3 mm.	65%
Mycteria americana	39.4 mm.	50.3 mm.	78%

It is quite impossible to get the exact area of the irregular occipital surface of muscle attachment. A single measurement, the maximum transverse diameter, is therefore taken as a rough index. This quantity is obtained by measuring the extreme distance between the right and left extremities of the occipital area as delineated by the lambdoidal crest.

The following table again shows the fossil stork to be closely allied to the typical species of *Ciconia*.

TABLE OF MEASUREMENTS, COMPARING THE OCCIPITAL AREA WITH THE CRANIAL WIDTH

	Maximum Width of Occiput	Maximum Width of Cranium	Ratio
Ciconia maltha	41.8 mm.	55.5 mm.	75.3%
Ciconia alba	35.5 mm.	47. mm.	75.5%
Euxenura maguari	40.1 mm.	51.3 mm.	77.1%
Mycteria americana	42. mm.	50. mm.	82 %

TABLE OF MEASUREMENTS, COMPARING THE OCCIPITAL WIDTH WITH THE OCCIPITAL HEIGHT

	Maximum Width	Maximum Height	Ratio
Ciconia maltha	41.8 mm.	23.7 mm.	59 %
Ciconia alba	35.5 mm.	20.3 mm.	57.4%
Euxenura maguari	40.1 mm.	25.4 mm.	49 %
Mycteria americana	42. mm.	24.7 mm.	59 %

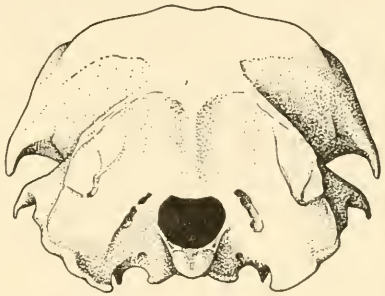
With regard to point number three, the pattern traced by the intermuscular lines upon the occipital area is not one that can be expressed in numerical terms, but the general form of the area in the Asphalt Stork is more closely like that in the typical *Ciconia* than it is like that of the South American *Euxenura*.

The rostral fragment that accompanies the cranium shows very little except that the beak was straight, without either the upturn of *Jabiru* or the ibis-like hook of *Mycteria*. The bony nares are long and poorly defined slits, in contrast to the more rounded and well defined nares of *Mycteria*. Both *Euxenura* and *Ciconia* have the slit-like type seen in the fossil beak.

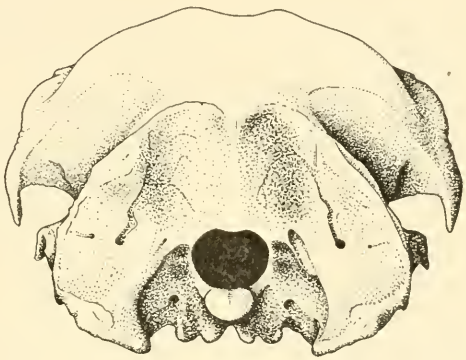
The storks are very poorly represented in the collections from Rancho La Brea, but they occupy a prominent place in more limited collections from McKittrick, owing apparently to a difference in the local terrain. The matrix also at McKittrick seems to have been less perfectly preservative, and specimens crumbled more easily in the differential move-

ment of the matrix. We have therefore a great paucity of the more fragile bird skulls.

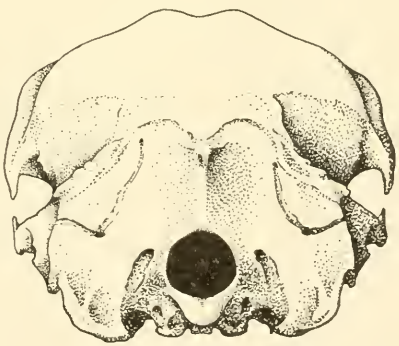
This specimen is the only one that I have been able to examine that can be assigned to the true storks. The result of this and other studies that I have made is to confirm the original assignment to the genus *Ciconia*.



A



B



C

Occipital aspect of cranium. (x 1/1 approx.)

A. *Ciconia alba.*
B. *Ciconia maltha.*
C. *Euxenura maguari.*

Drawings by Gerhard Bakker.

28,898

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